User's Guide
Model 9302/9304
Cryogenic Temperature Monitor

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The Model 9302/9304 does not contain any user serviceable parts. Do not open the enclosure. Do not install substitute parts or perform any unauthorized modification to the product. For service or repair, return the product to SII or an authorized service center.

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Preparing the Monitor for Use

Model Identification

The model number is identified on the front and rear panel of the instrument as well as in various instrument displays.

Model	Description
Model 9302-110	Cryogenic temperature monitor with **two** standard multi-function sensor input channels set for AC power line voltages from 100 to 120VAC.
Model 9302-220	Cryogenic temperature monitor with **two** standard multi-function sensor input channels set for AC power line voltages from 200 to 220VAC.
Model 9304-110	Cryogenic temperature monitor with **four** standard multi-function sensor input channels set for AC power line voltages from 100 to 120VAC.
Model 9304-220	Cryogenic temperature monitor with **four** standard multi-function sensor input channels set for AC power line voltages from 200 to 220VAC.

Table 1: Model Identification

Supplied Items

Verify that you have received the following items with your monitor. If anything is missing, contact Scientific Instruments, Inc. directly.

- Model 9302 or 9304 Cryogenic Temperature Monitor.
- User's Manual (PN 090-264).
- SII software CD (PN 093-033).
- Two dual input connector/cable assemblies (PN 402-015).
- Relay/Aout connector, 6-pin terminal block plug, (PN 231-552).
- Certificate of Calibration.

Verify the AC Power Line Voltage Selection.

The AC power line voltage is set to the proper value for your country when the controller is shipped from the factory. This setting is marked on the rear panel just above the AC Power Entry module.

AC power line voltage setting is made by internal component selection. Refer to the section on AC Line Voltage Selection for details.

Apply Power to the Monitor

Connect the power cord and turn the monitor on by switching the power switch on the rear panel to the '1' position. The front panel will show a Power Up display with the model number and firmware revision.

While the Power Up display is shown, the monitor is performing a self-test procedure that verifies the proper function of internal data and program memories, remote interfaces and input channels. If an error is detected during this process, the monitor will freeze operation with an error message display. In this case, turn the unit off and refer to Appendix B: Troubleshooting Guide.

SI 9304
Firmware Rev: 2.08B
IP: 192.168.0.4

Caution: Do not remove the instrument's cover or attempt to repair the monitor. Other than the AC line voltage selection jumpers, there are no user serviceable parts, jumpers or switches inside the unit. Further, there are no software ROM chips, trim pots, batteries or battery-backed memories.
All firmware installation and instrument calibration functions are performed externally via the remote interfaces.

After about ten seconds, the self-test will complete and the monitor will begin normal operation.

※ **NOTE:** The Model 9302/9304 attempts to connect with the Ethernet as soon as power is applied. If there is a valid Ethernet connection, the power-up sequence is immediate. However, if there is no connection, the Model 9302/9304 will delay about 10 seconds before showing the power-up screen.

Factory Default Setup

A monitor with factory default settings will have an operational display like the one shown here. The dash (**-**) or dot (**.**) characters indicate that there is no sensor connected.

Channel A 301.455K
Channel B 312.523K
Channel C 362.321K
Channel D 394.312K

Note that, in some cases, there will be an erratic temperature display when no sensor is connected. This is not an error condition. The high input impedance of the monitor's input preamplifier causes erratic voltage values when unconnected.

Input Channel factory defaults are:
Sensor Units: Kelvin.
Sensor Type: Pt100 385 (DIN standard 100Ω Platinum RTD)
Alarm Enables: Off

To change these, press the **Enter** key then refer to the Input Channel Setup Menu section.

Instrument setup factory defaults are:
Display Filter Time Constant: 4.0 Seconds.
Display Resolution: 3 digits.
RS-232 Baud Rate: 9600
Data Logging: Off

To change these, press the **Enter** key and then select the System Setup Menu.

Analog Output:
Control Channel: ChA
Enable: No
Offset: 300
Gain: 0.5

To change these, press the **Enter** key and then select Analog Output.

Relay settings:
Relay #1, Relay #2: Off.

To change these, press the **Enter** key and then select Relays.

Network settings are:
IP Address: 192.168.0.4.
Subnet Address: 255.255.255.0

※ **NOTE**: Factory defaults may be restored at any time by use of the following sequence: 1) Turn power to the Model 9302/9304 OFF. 2) Press and hold the Enter key while turning power back ON.

Technical Assistance

Trouble shooting guides and user's manuals are available on our web page at http://www.scientificinstruments.com.

Technical assistance may be also be obtained by contacting SII as follows:

Scientific Instruments, Inc.
4400 West Tiffany Drive
West Palm Beach, FL 33407

Telephone: (561) 881-8500 FAX: (561) 881-8556
e-mail: sales@scientificinstruments.com

For updates to LabVIEW™ drivers, utility software and product documentation, go to our web site and select the Download area.

Current Firmware Revision Level
As of January 9, 2006 the current firmware revision level for the Model 9302/9304 series is 2.08B.

Current Hardware Revision Level
As of January 9, 2006, the current hardware revision level for the Model 9302/9304 series is B. Hardware cannot be upgraded in the field.

Returning Equipment

If an instrument must be returned to Scientific Instruments for repair or recalibration, a Return Material Authorization (RMA) number must first be obtained from the factory. This may be done by Telephone, FAX or e-mail.

When requesting an RMA, please provide the following information:

1. Instrument model and serial number.
2. User contact information.
3. Return shipping address.
4. If the return is for service, please provide a description of the malfunction.

If possible, the original packing material should be retained for reshipment. If not available, consult factory for packing assistance.

SII's shipping address is:

Scientific Instruments, Inc.
4400 West Tiffany Drive
West Palm Beach, FL 33407

Options and Accessories

Instrument Accessories

SII Part #	Description
402-016	RS-232 Null Modem Cable, 6’
402-002	AC Power Cord
231-552	Terminal block for Analog Output and Relay connections.
402-015	Dual Sensor Cable, 2 x 8 foot
402-014	Shielded Sensor Connector Kit (DB9)
305-240	Panel Mount hardware kit. See Appendix C
300-010	Bench top instrument stand. See Appendix C
300-011	Tilt-stand and carry handle.
090-264	Additional User’s Manual/CD

Table 2: Model 9302/9304 Instrument Accessories

Cryogenic Accessories

SII Part #	Description
Si410	Si410 series Silicon Diode Temperature Sensors. Temperature range: 1.5 to 450K
RO600	RO600 Ruthenium Oxide Sensor, 1 kΩ
RO105	RO105 Ruthenium Oxide Sensor, 100 kΩ
Pt100	Pt100 series Platinum RTD, 100Ω
Ga300	Ga300 series Gallium Arsenide Sensor

Table 3: Cryogenic Accessories

Specifications, Features and Functions

Specification Summary

User Interface

Display Type: 20 x 4 character or 140x32 graphics VFD.

Number of Inputs Displayed: Model 9302: 2. Model 9304: up to 4.

Keypad: Sealed Silicon Rubber.

Temperature Display: Six significant digits, autoranged.

Display Update Rate: 0.5 Seconds.

Display Units: K, C, F or native sensor units.

Display Resolution: User selectable to seven significant digits.

Input Channels

There are two input channels on the Model 9302 and four on the Model 9304. They are identical and each may be independently configured for any of the supported sensor types.

Sensor Connection*:* 4-wire differential. DB-9 receptacles connect two channels. Connections are described in the "Sensor Connections" section.

Isolation: Sensor circuits are not electrically isolated other internal circuits. However, there is a 'single point' internal connection to Earth (or Shield) ground in order to minimize noise coupling.

Input Protection: ±30 Volts maximum.

Supported Sensors*:* Include:

Type	Excitation	Temperature Range
Cernox™	Constant-Voltage AC	0.3 to 420K
Ruthenium Oxide	Constant-Voltage AC	50mK to 273K
Thermistors	Constant-Voltage AC	70 to 325K
Rhodium-Iron	1mA DC	1.4 to 800K
Germanium	Constant-Voltage AC	0.3K to 100K
Carbon Glass	Constant-Voltage AC	1.4K to 325K
Silicon Diode	10μA DC	1.4 to 475K
Platinum RTD	1mA DC	14 to 1200K
GaAlAs Diode	10μA DC	25K to 325K

***Sensor Selection**:* Front Panel or remote interface. There are no internal jumpers or switches.

***Sensor Resolution**:* Sensor Dependent. See Sensor Performance Data table.

***Sensor Excitation**:* Constant current mode: 1mA, 100μA or 10μA.
Constant voltage mode: 1.0V, 10mV, 3.333mV and 1.0mV RMS. Excitation Current: 1.0mA to 10nA in steps of 5% of power.

Resistance Measurement type: Ratiometric bridge.

Resistance Range: Constant-voltage, Maximum resistance: 1V = 1MΩ, 10mV = 1MΩ, 3.3mV = 430KΩ, 1.0mV = 100KΩ.

AC Excitation Frequency: Resistor sensors in constant-voltage mode: 1.25Hz bipolar square wave.

***Sample Rate**:* 10Hz per channel in all measurement modes.

***Measurement Resolution**:* Sensor Dependent. See Sensor Performance Data table.

***Digital Resolution**:* 24 bits.

***Measurement Drift**:* <15ppm/°C.

Measurement Filter: 0.5, 1, 2, 4, 8 and 16 Seconds.

***Calibration Curves**:* Built-in curves for industry standard sensors plus six user curves with up to 200 entries each. Interpolation is performed using a Cubic Spline.

CalGen®: Calibration curve generator fits any Diode or resistor sensor curve at 1, 2 or 3 user specified temperature points.

Analog Output

***Type**:* Voltage output, 0 to 4.096 Volts. Input impedance: 600Ω.

***Digital Resolution**:* 0.0015% of full-scale range.

Relay Outputs

***Number**:* Two. Fully independent.

Contact Rating: 1 Amps @ 30VDC.

Contacts Available: Normally-Open. Rear Panel.

Connector: Detachable terminal block.

Status Outputs

***Visual Alarms**:* Independent visual alarms can be configured for each input. They are displayed on the front panel display and as an LED indicator.

***Status reported via Remote Interface**:* Input channel alarms.

Remote Interfaces

Remote interfaces are electrically isolated to prevent ground loops.

RS-232: Serial port is an RS-232 standard null modem. Rates are 9600, 38,400 and 57,600 Baud.

Ethernet: Industry standard 10-BaseT. Electrically isolated

Language: Remote interface language is IEEE SCPI compliant. National Instruments LabVIEW™ drivers available for all interfaces.

Firmware

Internal firmware and all data tables are maintained in FLASH type memory.

General

Ambient Temperature*:* 25°C ± 5°C for specified accuracy.

Mechanical*:* 5.75"W x 2.875"H x 8.75"D.

Weight*:* 3 Lbs.

Enclosure: Aluminum Extrusion. Machined Aluminum front and rear panels.

Power Requirement*:* 100 – 120 or 200 – 240 VAC. 50 or 60Hz, 25 Watts.

Input Channels

There are two independent, multi-purpose input channels on the Model 9302 and four on the Model 9304; each of which can separately be configured for use with any supported sensor.

The Sensor Type is selected by the user via the microprocessor. Values of excitation current, voltage gain etc. will be determined by the microprocessor and used to automatically configure the channel. There are no internal jumpers or switches.

Constant-Current Sensor Excitation

Cryogenic sensors including Diode and Platinum devices require a constant-current excitation. To support this, the Model 9302/9304 has a constant-current excitation mode with three selectable outputs of 10μA, 100μA and 1.0mA DC.

The maximum compliance of the constant-current source is 2.45V.

Temperature is measured with diode type sensors by providing a 10μA excitation current and reading the resulting voltage.

The Model 9302/9304 uses a Ratiometric bridge technique to measure resistor sensors. Here, the measurement is the ratio between the sensor resistance and an internal calibration standard resistance. This effectively cancels the DC drift and electronic noise associated with the internal voltage reference and constant-current source circuitry.

Resistor sensors may use any of the three constant-current settings.

Constant-Voltage Sensor Excitation

A unique feature of the Model 9302/9304 is the constant-voltage excitation mode where current applied to the sensor is autoranged in order to maintain a constant RMS voltage level across the sensor.

A constant-voltage excitation is necessary since the resistance thermometers used below about 10K exhibit a negative temperature coefficient. Therefore, a constant-voltage measurement will reduce the power dissipation in the sensor as temperature decreases. By maintaining a low power levels, sensor self-heating errors that occur at very low temperatures are minimized.

In the constant-voltage mode, sensor excitation is a 1.25Hz bipolar square-wave. This provides DC offset cancellation without loss of signal energy.

Available voltage selections are 1.0V, 10.0mV, 3.33mV and 1.0mV RMS. The maximum and minimum sensor resistance that can be read is a function of the selected voltage bias.

Power dissipation in the sensor is computed by:

$$P_d = \frac{V_{bias}^2}{R_{sensor}}$$

Resistance Range Table		
Voltage Bias	**Min. Resistance**	**Max. Resistance**
1.0V	100Ω	1.0MΩ
10.0mV	10Ω	200KΩ
3.33mV	3.3Ω	100KΩ
1.0mV	1Ω	20KΩ

Table 4: Voltage Bias Selections

Excitation current sources used with constant-voltage bias are calibrated from 1.0mA to 0.1uA so that the accuracy of resistance measurement will be ±0.1%. Accuracy will steadily degrade at lower excitation currents down to the minimum available output current of 10nA where the accuracy of resistance measurement is about ±0.7%.

The tradeoff in measurement accuracy vs. minimum sensor excitation current is taken for two reasons:

1. The sensitivity of NTC resistor sensors is extremely high in the low temperature end of their range. Therefore the reduced measurement accuracy does not degrade temperature measurement accuracy.
2. The low current settings are required since sensor self-heating at low temperature is a very significant source of errors.

In order to minimize large jumps in self-heating, the Model 9302/9304 uses current sources to cover the 1.0mA to 10nA in steps of 5% power.

Resistance Measurement Accuracy		
Voltage Bias	**±0.1%**	**±0.7%**
10.0mV	10Ω - 100KΩ	1.0MΩ
3.33mV	3.3Ω - 43KΩ	430KΩ
1.0mV	1Ω - 10KΩ	100KΩ

Table 5: NTC Resistor Measurement Accuracy

Supported Sensor Types

A complete list of the sensor types supported by the Model 9302/9304 is shown below:

Sensor Type	Max. Voltage/ Resistance	Bias Type	Excitation Current	Typical Use
Diode	2.5V	CI	10μA	Silicon Diode, GaAs Diode.
ACR	1Ω to 1MΩ	CV	1.0mA to 10nA	NTC resistors including Ruthenium Oxide, Cernox™.
R16K10UA	16KΩ	CI	10μA	PTC/NTC Resistors.
R8K10UA	8KΩ	CI	10μA	PTC/NTC Resistors.
R6K100UA	6KΩ	CI	100μA	Platinum 1000
R2K100UA	2KΩ	CI	100μA	Platinum 1000
R625R1MA	625Ω	CI	1.0mA	Pt 100 > 800K.
R312R1MA	312Ω	CI	1.0mA	Pt 100 < 800K.

Table 6: Supported Sensors

Bias types are:

CI – Constant Current sensor excitation.

CV – Constant Voltage sensor excitation. Voltages of 10.0mV, 3.3mV and 1.0mV RMS may be selected. Excitation current autoranges from 1.0mA to 10nA in order to maintain the selected voltage.

Silicon Diode Sensors

Silicon Diode sensors (2-volt diodes) are configured with a 10μA current source excitation and a 2.5 Volt unipolar input voltage range.

Gallium-Arsenide Diode Sensors

Gallium-Arsenide Diodes, or 6-Volt Diodes, can be used down to a minimum temperature of about 25K. This limitation is imposed by the fact that the controller's maximum input voltage is 2.25 Volts.

Gallium-Arsenide sensors do not fit standard calibration curves, therefore, the user must provide a sensor-specific curve before using this type sensor.

To use diodes, Gallium-Arsenide select the Diode input sensor type.

PTC Resistor Sensor Devices (RTDs)

The Model 9302/9304 supports all types of Positive-Temperature-Coefficient (PTC) resistive sensors. Various combinations of excitation current and full-scale input voltage allow the user to trade off accuracy vs. sensor self heating.

The Supported Sensors table above gives a complete list of combinations that can be selected.

Standard calibration curves are provided for DIN43760 and IEC751 Platinum sensors. While these curves are based on a 100Ω sensor, they may easily be extended to other resistance values by using the Multiplier field of the sensor setup.

A table of recommended setups for various types of PTC resistor sensors is shown here:

Type	Sensor Type	Sensor Excitation	TC	Calibration Units
Platinum, 100Ω	R625R1MA	1.0mA, AC/DC	(+)	Ohms
Platinum, 1000Ω	R6K100UA	100μA, AC/DC	(+)	Ohms
Platinum, 10KΩ, < 425K	R16K10UA	10μA, AC/DC	(+)	Ohms
Rhodium-Iron	R312R1MA	1.0mA, AC/DC	(+)	Ohms

Table 7: PTC Resistor Sensor Configuration

NTC Resistor Sensor Devices

The Model 9302/9304 also supports almost all types of Negative-Temperature-Coefficient (NTC) resistive sensors. Using AC, constant-voltage excitation, these sensors can be used down to extremely low temperatures.

Examples of NTC resistor sensors include: Ruthenium-Oxide, Cernox™, Carbon Glass™, Germanium and Thermistors.

Calibration tables may be entered either directly in Ohms or in (base 10) Log of Ohms.

A table of recommended setups for various types of NTC resistors sensors is shown here:

Type	Sensor Type	Sensor Excitation	TC	Calibration Units
Carbon Glass™	ACR	1.0 to 10.0mV AC	(-)	LogOhm
Germanium	ACR	1.0 to 10.0mV AC	(-)	LogOhm
Cernox™	ACR	1.0 to 10.0mV AC	(-)	LogOhm
Ruthenium Oxide	ACR	1.0 to 10.0mV AC	(-)	LogOhm
Thermistors	ACR	1.0 to 10.0mV AC	(-)	LogOhm

Table 8: NTC Resistor Sensor Configuration

Sensor Performance Summary

Sensor Type	Silicon Diode	100Ω Platinum DIN43760	1000Ω Platinum DIN43760	10KΩ Platinum DIN43760
Input Configuration	2.5V, 10μA	625Ω, 1.0mA	3125Ω, 100μA	16KΩ, 10μA
Sensor Sensitivity	300K: 2.4mV/K 77K: 1.9mV/K 4.2K 30mV/K	800K: 0.36Ω/K 300K: 0.39Ω/K 77K: 0.42Ω/K 30K: 0.19Ω/K	600K: 3.7Ω/K 300K: 3.9Ω/K 77K: 4.2Ω/K 30K: 1.9Ω/K	300K: 39Ω/K 77K: 42Ω/K 30K: 19Ω/K
Measurement Accuracy	80μV + 0.00005 * SenVal	0.004Ω + 0.0001 * SenVal	600K: 38mΩ 300K: 38mΩ 77K: 4.7mΩ 30K: 4.7mΩ	300K: 380mΩ 77K: 50mΩ 30K: 50mΩ
Temperature Measurement Accuracy	(80μV + 0.00005 * SenVal) / SenSen	(0.004Ω + 0.0001 * SenVal) / SenSen	600K: 6.2mK 300K: 6.2mK 77K: 2.8mK 30K: 9.8mK	300K: 6.2mK 77K: 2.8mK 30K: 9.8mK
Measurement Resolution	15μV	0.002Ω	600K: 15mΩ 300K: 15mΩ 77K: 1.8mΩ 30K: 1.8mΩ	300K: 150mΩ 77K: 18mΩ 30K: 1.8mΩ
Temperature Resolution	15μV / SenSen	0.002Ω / SenSen	600K: 4mK 300K: 4mK 77K: 0.5mK 30K: 1.0mK	300K: 4mK 77K: 0.5mK 30K: 1.0mK
Power Dissipation	4.2K: 17μW 77K: 12μW	30K: 3.7μW 77K: 20μW	30K: 370nW 77K: 2.0μW	30K: 37nW 77K: 200nW
Magneto resistance	Very Large	Moderate	Moderate	Moderate

Table 9: Sensor Performance for Diodes and Pt Sensors.

SenVal: The sensor output at a given temperature in units of Volts or Ohms depending on the sensor type.

SenSen: The sensor sensitivity at a given temperature in units of Volts/Kelvin or Ohms/Kelvin depending on the sensor type.

Example: Si410 Silicon Diode

T(K)	SenVal [V]	SenSen [V/K]	Accuracy [μV]	Accuracy [K]	Resolution [μV]	Resolution [K]
4	1.65	0.0321	163	0.005	15	0.0005
70	1.04	0.00169	132	0.078	15	0.0089
300	0.56	0.00228	108	0.047	15	0.0066

Sensor Type	Ruthenium Oxide[2]	Carbon Glass™[2]	Cernox™[2]
Example Sensor	**RO600A**	**CGR-1-500**	**CX-1050**
Sensor Sensitivity	1.0K: 1260Ω/K 4.2K: 80.3Ω/K 20K: 3.96Ω/K	1.4K: 520KΩ/K 4.2K: 422Ω/K 77K: 0.1Ω/K 300K: 0.01Ω/K	1.4K: 240KΩ/K 4.2K: 2290Ω/K 77K: 2.15Ω/K 300K: 0.16Ω/K
Measurement Accuracy	10Ω + 0.0004*SenVal	1.4K: 728Ω 4.2K: 0.58Ω 77K: 14mΩ 300K: 0.02Ω	1.4K: 675Ω 4.2K: 5.1Ω 77K: 161mΩ 300K: 40mΩ
Temperature Measurement Accuracy	(10Ω + 0.0004*SenVal) /SenSen	1.4K: 1.4mK 4.2K: 1.4mK 77K: 150mK 300K: 2.1K	1.4K: 2.2mK 4.2K: 2.2mK 77K: 75mK 300K: 295mK
Measurement Resolution	0.02Ω + 0.0001*SenVal	4.2K: 11mΩ 77K: 0.2mΩ 300K: 0.2mΩ	4.2K: 46mΩ 77K: 1.8mΩ 300K: 0.5mΩ
Temperature Resolution	(0.02Ω + 0.0001*SenVal) /SenSen	4.2K: 30μK 77K: 1.2mK 300K: 12mK	4.2K: 50μK 77K: 0.85mK 300K: 3.5mK
Power Dissipation	1.0K: 42nW 4.2K: 73nW	1.4K: 962pW 4.2K: 171nW	1.4K: 1.1nW 4.2K: 20nW
Magneto-resistance	<2% for H<2T	Moderate	<1% for H<2T
[2] 10mV Constant-Voltage bias			

Table 10: Sensor Performance for NTC sensors.

Factory Installed Sensors

A listing of the sensors installed in the Model 9302/9304 is given below. Additional information about these devices can be found in Appendix A.

Name	Description
Cryo-con S700	Cryo-con S700 series Silicon Diode. Range: 1.4 to 495K. 10μA constant current excitation.
LS DT-670	Lakeshore Silicon Diode Curve 11 for DT-670 series diodes. Range: 1.4 to 500K. 10μA constant current excitation.
LS DT-470	Lakeshore Silicon Diode Curve 10 for DT470 series diodes. Range: 1.4 to 495K. 10μA constant current excitation.
Si410	Scientific Instruments, Inc. 410 Diode Curve. Range: 1.5 to 450K. 10μA excitation.
Pt100 385	DIN43760 standard 100Ω Platinum RTD. Range: 23 to 1023K, 1mA excitation.
Pt1K 385	1000Ω at 0°C Platinum RTD using DIN43760 standard calibration curve. Range: 23 to 1023K, 100μA excitation.
Pt10K 385	10KΩ at 0°C Platinum RTD. Temperature coefficient 0.00385, Range: 23 to 475K, 10μA excitation.
RhFe 27, 1mA	Rhodium-Iron. 27Ω at 0°C
RO-105 AC	SI RO-105 Ruthenium Oxide sensor. AC excitation. Use only the 1.0V constant voltage excitation.
RO-105 DC 10uA	SI RO-105 with DC excitation. This is the recommended configuration for this high resistance sensor.
RO-600 AC	SI RO-600 Ruthenium Oxide sensor. Constant voltage AC excitation.

Table 11: Factory Installed Sensors

CalGen™ Calibration Curve Generator

The CalGen™ feature is used to generate new calibration curves for Silicon Diode or Platinum sensors. This provides a method for obtaining higher accuracy temperature measurements without expensive sensor calibrations.

Curves can be generated from any user-selected curve and are written to a specified internal user calibration curve area.

The CalGen™ function may be performed in the instrument by using the front panel. Alternatively, the feature is also implemented in the Model 9302/9304 utilities software.

Thermal EMF and AC Bias Issues

DC offsets can build up in cryogenic temperature measurement systems due to Thermocouple effects within the sensor wiring. Careful wiring can minimize these effects. However, in a few systems, errors

induced by thermal EMFs can result in unacceptable measurement inaccuracies. These cases will require the use of an AC bias, or chopped sensor excitation, in order to remove DC offsets.

Sensor Wiring

Diode and Platinum RTD type sensors use a DC measurement scheme. Therefore, the only effective method of minimizing thermocouple (DC) offsets is to wire temperature sensors so that connections between dissimilar metals are grouped together. For example, the connection between sensor leads and cryostat wiring should be kept close together. This way, the Thermocouple junctions formed by the connection will have equal-but-opposite voltages and will cancel each other.

Frequently, sensor leads are made from the same material as the cryostat wires. Therefore, there is no significant thermocouple formed by this connection.

In a four-wire measurement scheme, only connections in the voltage sense lines can cause measurement errors. So, the sense wires should have adjacent contacts in a multi-pin connector in order to minimize any temperature difference between them.

Usually, the ‘connection to copper’ in a cryostat is made at the top of the cryostat. After this point, Thermal EMFs cannot be generated.

AC Excitation

When a sensor type of ACR, or AC Resistance, is selected, the Model 9302/9304 uses a 1.25Hz square-wave sensor excitation. This eliminates DC offsets by computing the sensor resistance at two different excitation points. This method will not work diode sensors.

Output Channel Features

Alarm Outputs

Alarm outputs include a LED indicator and an on-screen display.

Alarms may be asserted based on high or low temperature conditions.

There is a 0.25K hysteresis built into the high and low temperature alarms.

Analog Output

The Model 9302/9304 has a zero to 4.096 Volt analog output that can be scaled to the current temperature reading on any selected input channel.

The Analog output has an output impedance of 600 Ohms.

The formula used to scale the output voltage is:

$$Output = (Temperature - Offset) \times Gain$$

Relay Outputs

There are two auxiliary dry-contact relay outputs available on the rear panel. They may be independently asserted upon a high or low temperature condition on any selected input channel.

Normally-open contacts are available at the rear panel. Contact ratings are: 1 Amp @ 24VDC.

There is a 0.25K hysteresis built into the high and low temperatures.

Remote Interfaces

10-BaseT Ethernet and RS-232 interfaces are standard on the Model 9302/9304. All functions and read-outs available from the instrument may be completely controlled by any of these interfaces.

The 10-BaseT Ethernet connection is made via the RJ-45 connector on the rear panel.

The Serial port is an RS-232 standard null modem with male DB9 connector. Rates are 9600, 38,400 and 57,200 Baud.

The programming language used by the Model 9302/9304 is identical for all interfaces and is SCPI language compliant. The Standard Command Protocol for programmable Instruments (SCPI) is a sub section of the IEEE-488.2 standard and is a tree structured ASCII command language that is commonly used to program laboratory instruments.

Rear Panel Connections

The rear panel of the Model 9302/9304 is shown here:

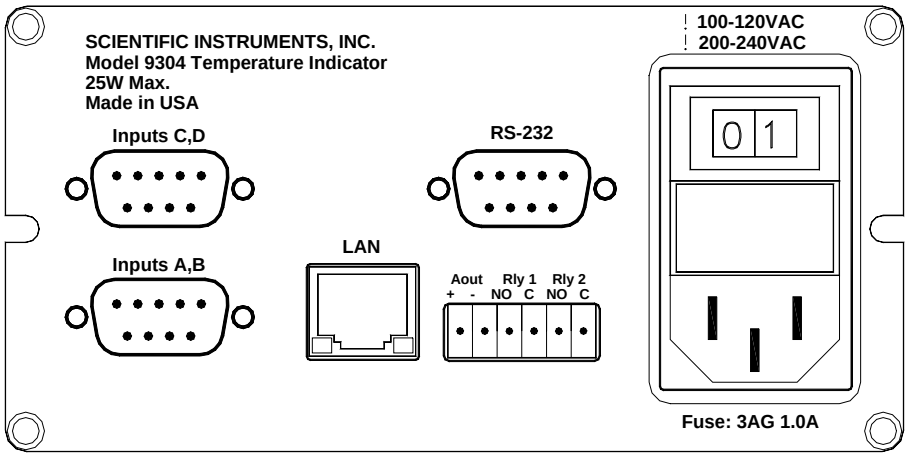


Figure 1: Model 9302/9304 Rear Panel Layout

AC Power Connection

The Model 9302/9304 requires single-phase AC power of 50 to 60 Hz. Voltages are set by the factory to either 110VAC or 220VAC.

Caution: *Protective Ground:* To minimize shock hazard, the instrument is equipped with a three-conductor AC power cable. Plug the power cable into an approved three-contact electrical outlet or use a three-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

The power jack and mating plug of the power cable meet Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) safety standards.

Power requirement is 25 Watts.

User-replaceable fuses are incorporated in the Power Entry Module.

AC Line Voltage Selection

The Model 9302/9304 is set at the factory for AC line voltages of 100 – 120VAC or 200 – 240VAC. The selection is marked on the rear panel above the power entry module.

Voltage selection can be changed in the field by opening up the unit and moving jumper chips.

To change the voltage selection, please follow the procedure below:

1. Disconnect the AC power cord.
2. Lay the unit upside-down on a flat surface and remove the four screws that hold the rear panel in place.
3. Gently slide the circuit board out by about two inches. This will expose the voltage selection jumpers shown here.

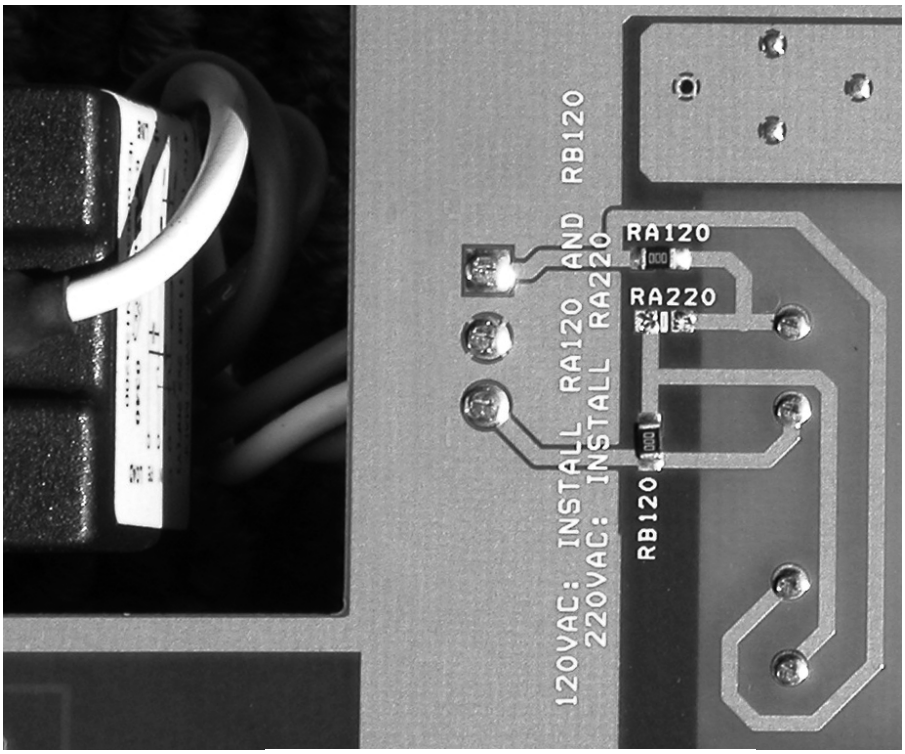


Figure 2: Voltage Selection Jumpers

4. Add or remove the chip jumpers required to select the desired voltage. Note: the chip jumpers are easily removed by using two soldering irons. If you do not have a chip, substitute a short piece of wire.

Line Voltage	Remove	Install
100VAC - 120VAC	RA220	RA120, RB120
220VAC - 240VAC	RA120, RB120	RA220

5. Slide the unit back together and re-install the four screws. Mark the voltage selection on the rear panel in the space provided.

Do NOT reconnect the AC power cord until the unit is completely reassembled.

Fuse Replacement

Access to the Model 9302/9304's fuses and voltage selector switch is made by using a screwdriver to open fuse drawer in the power entry module. The fuse drawer cannot be opened while the AC power cord is connected.

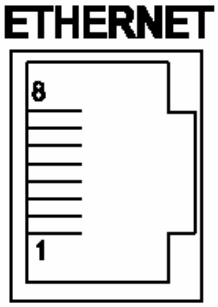
In the fuse drawer, there is one active fuse and one spare. Fuse current is determined by the AC line voltage.

Line Voltage	Fuse	Example
100VAC - 120VAC	1.0A slow-blow	Littelfuse 313 002
220VAC - 240VAC	0.5A slow-blow	Littelfuse 313 001

Table 12: AC Power Line Fuses

Ethernet (LAN) Connection

The 10BaseT Ethernet network (RJ-45) system is used by the Model 9302/9304 for Ethernet network connectivity. The 10 Mbps twisted-pair Ethernet system operates over two pairs of wires. One pair is used for receiving data signals and the other pair is used for transmitting data signals. This means that four pins of the eight-pin connector are used.



Pin	Name	Description
1	+Tx	+ Transmit Data
2	-Tx	- Transmit Data
3	+RX	+ Receive Data
4	N/C	Not Connected
5	N/C	Not Connected
6	-Rx	- Receive Data
7	N/C	Not Connected
8	N/C	Not Connected

Figure 3: LAN RJ-45 Pinout

10BaseT Straight Through (Patch) Cable

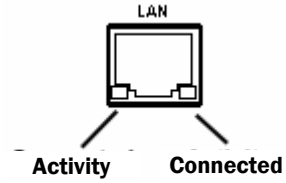
When connecting the Model 9302/9304 to a hub or switch, a standard 'patch' cable is used. This will connect the instrument's transmit lines to the hub's receive lines etc.

10BaseT Crossover Cable

When connecting the Model 9302/9304 directly to the computer, the transmit data pins of the computer should be wired to the receive data pins of the Model 9302/9304, and vice versa. The 10BaseT **crossover cable** should be used for this purpose. A crossover cable is usually a different color than the straight through patch cable.

Ethernet (LAN) Connector LEDs

The RJ-45 LAN connector on the rear panel of the Model 9302/9304 has two green LEDs. The left most LED indicates that a valid connection has been made to a hub or computer.



If the LAN is plugged in and the 'Connected' LED is not on, there is a problem that must be addressed before you can communicate with the instrument. Possible problems are:

1. Using the wrong type of cable. For example, using a Crossover Cable to connect the Model 9302/9304 to a hub instead of a computer. See the sections above.
2. Connection to the wrong type of hub. The hub must be capable of accepting 10-BaseT connections. Some older hubs do not support this.

The right most LED indicates activity on the LAN. It should flicker periodically during normal operation.

Sensor Connections

All four sensor connections are made at the rear panel of the Model 9302/9304 using the two DB-9 receptacles provided. There are two channels on each connector.

Four Wire Sensor Connections

Silicon Diode and all resistor type sensors should be connected to the Model 9302/9304 using the four-wire method. It is strongly recommended that sensors be connected using shielded, twisted pair wire. Cable shields should be dressed for connection to the conductive backshell of the connector. Signal connection is as follows:

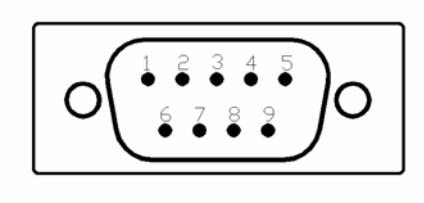


Figure 4: Input Connector

Input Channel	Connector	Signal	Pin
ChA	Lower	Current(+)	8
ChA	Lower	Current(-)	9
ChA	Lower	Sense(+)	4
ChA	Lower	Sense(-)	5
ChB	Lower	Current(+)	6
ChB	Lower	Current(-)	7
ChB	Lower	Sense(+)	1
ChB	Lower	Sense(-)	2
ChC	Upper	Current(+)	8
ChC	Upper	Current(-)	9
ChC	Upper	Sense(+)	4
ChC	Upper	Sense(-)	5
ChD	Upper	Current(+)	6
ChD	Upper	Current(-)	7
ChD	Upper	Sense(+)	1
ChD	Upper	Sense(-)	2

Table 13: Sensor Input Connector Pinout

Caution: To ensure proper low noise operation, cable shields should be connected to the metal backshell of the connector. Please refer to the section on shielding and grounding for further information.

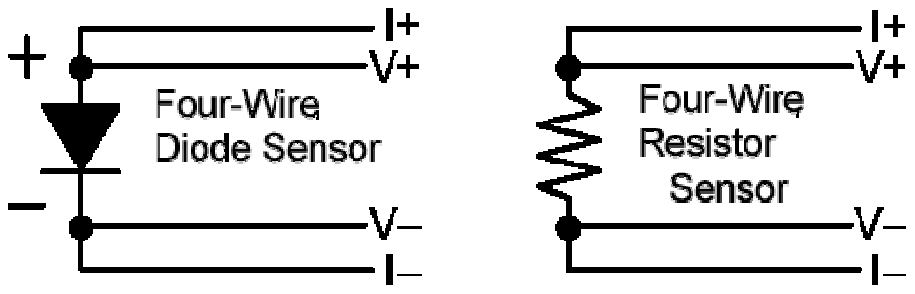
Color codes for the Dual Sensor Cable (SII part number 402-015) are as follows:

Input Channel	Color Code	Signal	Pin
ChA	White	Current(+)	8
ChA	Green	Current(-)	9
ChA	Red	Sense(+)	4
ChA	Black	Sense(-)	5
ChB	White	Current(+)	6
ChB	Green	Current(-)	7
ChB	Red	Sense(+)	1
ChB	Black	Sense(-)	2

Table 14: Dual Sensor Cable Color Codes

The cable used is Belden 8723. This is a dual twisted pair cable with individual shields and a drain wire. The shields and drain wire are connected to the DB9 connector's metal backshell in order to complete the shielding connection.

Four wire connections to the sensor are shown here for Diode and Resistor sensors:



Sensor Wiring

DC offsets can build up in cryogenic temperature measurement systems due to thermocouple effects within the sensor wiring. They are commonly referred to as Thermal EMF's. Careful wiring can minimize these effects.

The most effective method of minimizing thermocouple (DC) offsets is to wire temperature sensors so that connections between dissimilar metals are grouped together. For example, the connection between sensor leads and cryostat wiring should be kept close together. This way, the Thermocouple junctions formed by the connection will have equal-but-opposite voltages and will cancel each other.

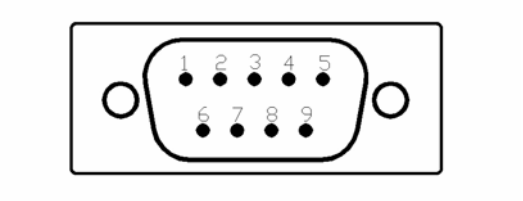
Frequently, sensor leads are made from the same material as the cryostat wires. Therefore, there is no significant thermocouple formed by this connection.

In a four-wire measurement scheme, only connections in the voltage sense lines can cause measurement errors. So, the sense wires should have adjacent contacts in a multi-pin connector in order to minimize any temperature difference between them.

Usually, the 'connection to copper' in a cryostat is made at the top of the cryostat. After this point, Thermal EMFs cannot be generated.

RS-232 Connections

The Model 9302/9304 uses a Female DB-9 connector for RS-232 serial communication. A Rear view of the connector, and it's pin-out are shown below.



Pin	Function
1	NC
2	RXD, Receive data
3	TXD, Transmit data
4	NC
5	Ground
6	NC
7	NC
8	NC
9	NC

Table 15: RS-232 Connection

The cable used to connect the Model 9302/9304 to a computer serial port is a Dual Female Null Modem cable. An example is Digikey Inc. part number AE1033-ND.

The wiring diagram for this cable is shown below. Note that communication with the Model 9302/9304 only requires connection of pins 2, 3 and 5. All other connections are optional.

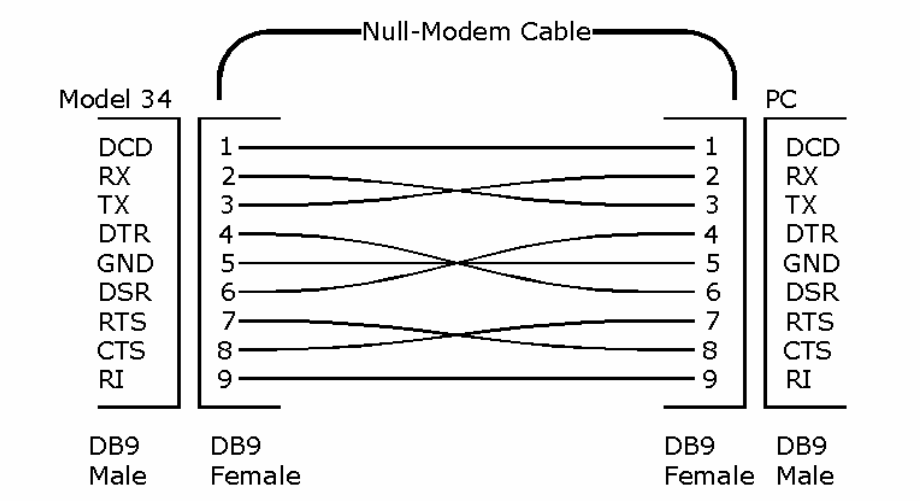


Figure 5: RS-232 Null Modem Cable

Analog Output and Relay Connections

Rear panel Analog Output and Relay connections are made using the six-pin pluggable 3.5mm terminal block provided. Pins are defined as shown in the table.

The six pin terminal block plug is a Weidmuller part number 161018. It is available from Digikey Inc. (281-1057-ND) or directly from Scientific Instruments, Inc. (231-552).

The Analog Output of the Model 9302/9304 will output zero to 4.096 Volts and has a 1000 Ohm output impedance. Connections are made using pins 1 and 2. Pin One of this block (left hand pin) is the positive output and Pin Two is the ground return. The shield of the output cable may be connected to Pin Two.

Both relays are dry-contact. Normally-open contacts are available on the terminal block. These contacts are open and close when the relay is energized. Contact ratings are 1 Ampere at 30 VDC.

Pin	Function
1	Aout +
2	Aout -
3	Relay 1 NO
4	Relay 1 Common
5	Relay 1 NO
6	Relay 2 Common

Table 16: Relay Connector Pinout

Mechanical, Form Factors and Environmental

Display

The display is a four line by twenty-character dot matrix VFD.

Enclosure

The Model 9302/9304 is bench mountable. Rack mounting can be done by using an optional rack mount kit.

Dimensions are: 5.75"W x 2.875"H x 8.75"D. Weight is 3Lbs.

Environmental and Safety Concerns.

Safety

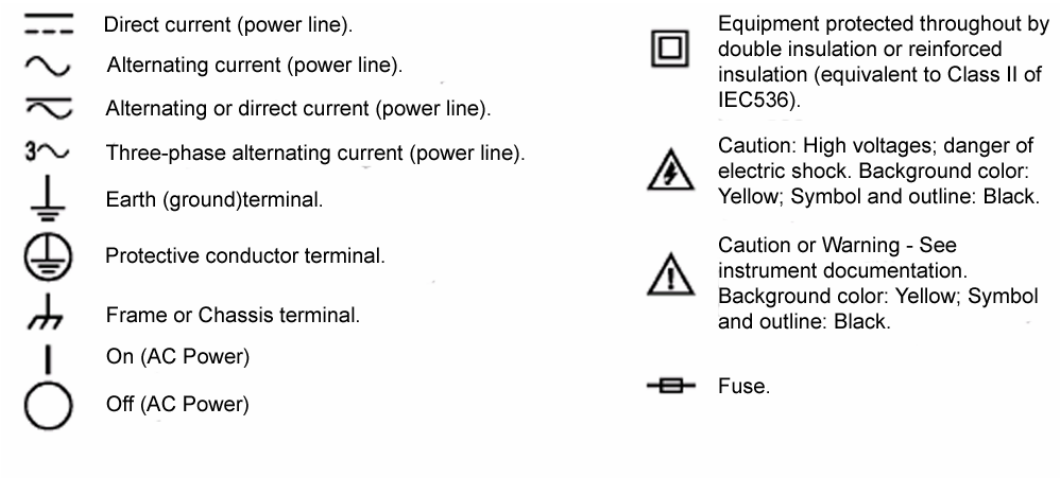
The Model 9302/9304 protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument.

- Keep Away From Live Circuits: Operating personnel must not remove instrument covers. There are no internal user serviceable parts or adjustments. Refer instrument service to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

- Cleaning: Do not submerge instrument. Clean exterior only with a damp cloth and mild detergent only.

- Grounding: To minimize shock hazard, the instrument is equipped with a three-conductor AC power cable. Plug the power cable into an approved three-contact electrical outlet only.

Safety Symbols


Direct current (power line).
Alternating current (power line).
Alternating or dirrect current (power line).
3
Three-phase alternating current (power line).
Earth (ground)terminal.
Protective conductor terminal.
Frame or Chassis terminal.
On (AC Power)
Off (AC Power)
Equipment protected throughout by double insulation or reinforced insulation (equivalent to Class II of IEC536).
Caution: High voltages; danger of electric shock. Background color: Yellow; Symbol and outline: Black.
Caution or Warning - See instrument documentation. Background color: Yellow; Symbol and outline: Black.
Fuse.

Environmental Conditions

Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area:

- Indoor use only.
- Altitude to 2000 meters.
- Temperature for safe operation: 5 °C to 40 °C.
- Maximum relative humidity: 80% for temperature up to 31 °C decreasing linearly to 50% at 40 °C.
- Power supply voltage fluctuations not to exceed ±10% of the nominal voltage.
- Over voltage category II.
- Pollution degree 2.
- Ventilation: The instrument has ventilation holes in its side covers. Do not block these holes when the instrument is operating.
- Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment is a definite safety hazard.

The User Interface

Overview

The Model 9302/9304 Cryogenic Temperature monitor's user interface consists of a four line by 20-character Vacuum Fluorescent display and a five key keypad. Most features and functions of the instrument can be accessed via this simple and intuitive menu driven interface. Complex functions, such as downloading a new sensor calibration curve, require using one of the remote interfaces.

The Home Status Display

At the root of the instrument's menu tree is the basic Home Status Display. This screen shows status information only.

Figure 6: Model 9302/9304 Front Panel

The Home Status display has three user-selectable formats as follows:

1. A four-line format that shows the current temperature on all four input channels plus any alarm conditions. Displayed text is 5mm high. Note that the channel name displayed is defined by the user. The factory default of "Channel A" etc. is shown here.

Channel A 323.455K
Channel B 123.465K
Channel C 93.152K
Channel D 63.123K

2. A two-line format that displays input channels A and B in a large, 10mm high, format.
3. A two-line format that displays input channels C and D in a large, 10mm high, format.

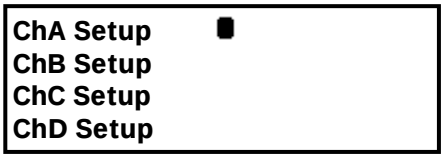
A 123.345K
B 92.146K

The display format is selected by pressing the ▲ or ▼ keys until the desired format is displayed.

The Home Status display can be selected from anywhere in the instrument's menu tree by pressing escape (▲) key. Note that pressing the ▲ key will abort any data entry operation that is in-progress.

Navigating the Menu Tree

Setup and configuration functions are performed by working with the monitor's menu tree. To access this tree from the Home Display, press the **Enter** key. The root menu shown here will be displayed.



The (▮) character in the far right column is the cursor. To exit this menu and return to the Home Display, press the (◀) key.

To navigate the menu, move the cursor up or down by pressing the ▲ or ▼ keys. The cursor will scroll down to show additional lines.

To select the line at the current cursor position, press the **Enter** key. In the case of the above display, pressing **Enter** will cause the monitor to display the input channel A setup, or ChA Setup menu.

If the cursor is positioned at a data entry menu line when the **Enter** key is pressed, the cursor will change into a data selection cursor as follows:

◥ Indicates that the selection is an enumeration field where sequential choices will be displayed each time the ▶ or ◀ key is pressed. To make the displayed selection, press the **Enter** key. To abort the selection process without making any change, press the ▲ key.

# Indicates that the selection is a numeric entry field. Pressing the ▶ or ◀ keys will increment or decrement the displayed number. To enter the displayed value, press the **Enter** key. To abort entry without making any changes, press the ▲ key.

Key	Description
Enter	1) From Home screen, enter setup menu. 2) Within a setup menu, Enter data or select a field (cursor display will indicate function).
▲	1) Scroll Display UP. 2) When in a field selection mode, abort entry and return to scroll mode (cursor display will indicate function).
▼	Scroll Display DOWN.
▶	Scroll to NEXT selection.
◀	1) In data selection mode, scroll to PREVIOUS selection. 2) Within a setup menu, return up the menu tree to the previous level (cursor display will indicate function).

Table 17: Function Key Descriptions.

LED indicators

There are three LED indicators on the right hand side of the instrument. They indicate the following:

Alarm (Red) – An enabled alarm condition is asserted.

Relay 1 (Green) – Relay #1 is energized.

Relay 2 (Green) – Relay #2 is energized.

Restoring Factory Defaults

Factory default settings may be restored with the following simple procedure:

1. Turn AC power OFF.
2. Press and hold the **Enter** key while turning AC power back ON. Keep the key pressed until you see the power-up display indicating that defaults have been restored.

The Input Channel Temperature Displays

An Input Channel Temperature Display consists of the input channel designator, a Temperature reading and the temperature units.

The input channel designator is a superscripted A, B, C or D. An input channel may also have a name that may be set by the user. On the Home Status display, only the first nine characters are displayed.

The temperature is a seven-character field and is affected by the Display Resolution setting in the system menu. This setting will be 1, 2, 3 or Full. Settings of 1, 2, or 3 indicate the number of digits to the right of the decimal point to display whereas the Full setting causes the display to be left justified in order to display the maximum number of significant digits possible.

If the Input Channel has been disabled, a blank display is shown.

Temperature units are selected in the individual input channel setup menus. Temperature Units may be K, C or F. When Sensor Units (S) is selected, the raw input readings are displayed. These will be in Volts or Ohms.

K	Kelvin
C	Celsius
F	Fahrenheit
Ω	Ohms
V	Volts

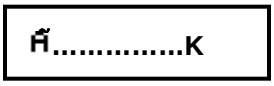
Table 18: Temperature Units

Sensor Fault Condition

A sensor fault condition is identified by a temperature display of seven dash (**-**) characters as shown here. The sensor is open, disconnected or shorted.

Reading Out of Range Condition

If a temperature reading is within the measurement range of the instrument but is not within the specified Sensor Calibration Curve, a display of seven dot (**.**) characters is shown.



Instrument Setup Menus

The root of the instrument's setup menus is accessed by pressing the **Enter** key from the Home display.

The Root Menu

The Root Menu displays the list of sub-menus that are used to configure the instrument.

Press the **Enter** key to descend into the sub-menu, or the ◀ key to return to the Home Status display.

Selections in the root menu are as follows:

Model 9302/9304 Root Menu		
1	**ChA Setup**	Press **Enter** to setup input channel A.
2	**ChB Setup**	Setup input channel B.
3	**ChC Setup**	Setup input channel C.
4	**ChD Setup**	Setup input channel D.
5	**Analog Output**	Setup the Analog Output
6	**Relay1 Setup**	Setup input Relay #1.
7	**Relay2 Setup**	Setup input Relay #2.
8	**System Setup**	Go to the System Setup Menu.
9	**Net Config**	Go to the Network Configuration Menu.
10	**Time / Date Setup**	Setup the instrument's time and date.

Table 19: Model 9302/9304 Root Menu

Input Channel Setup Menu

The Input Channel Setup menus are used to configure the two input channels. They are accessed from the root menu.

The first character on each line of these menus is always the input channel identifier, which is a superscripted A, B, C or D.

Scrolling to a line using the ▲ or ▼ keys and then pressing the **Enter** key will cause the cursor to change from a block cursor to the data entry cursor type that corresponds to the type of data that may be entered in this field.

ChA, ChB, ChC, ChD Setup Menu		
1	A 77.123 K	Input channel units. Temperature is displayed in real time on the left and is in the selected units. Selections are K, C, F or S. Here, S selects sensor units (Volts or Ohms).
2	ASen:Pt100 385	Sensor type selection. Allows selection of any user or factory installed sensor.
3	ABias Voltage: N/A	Bias voltage used in Constant-Voltage bias mode. If sensor does not support voltage bias, N/A is shown. Otherwise, selections are: 1.0V, 10mV, 3.3mV and 1.0mV
4	AHigh Alarm: 200.000#	Set point for the High Temperature alarm.
5	AHigh Enable: No	High temperature alarm enable. Selections are Yes or No.
6	ALow Alarm: 200.000#	Set point for the Low Temperature alarm.
7	ALow Alarm Ena: Yes	Low temperature alarm enable. Selections are Yes or No.

Table 20: Input Channel Setup Menus.

Temperature Units

The Units field (line 1) assigns the units that are used to display temperature for the input channel. Selections are K for Kelvin, C for Celsius, F for Fahrenheit and S for sensor units. Note that if the S option is selected, the actual sensor units will be displayed when the field is deselected. Sensor units are V for Volts and Ω for Ohms.

Sensor Type Selection

Line 2 selects the Sensor type for the input channel. When this field is selected, the scroll keys are used to scroll through all of the available sensor types. Factory installed sensors appear first and then user sensors. For a list of factory installed sensors, refer to Appendix A.

Bias Voltage Selection

The Model 9302/9304 supports constant-voltage AC excitation for resistor sensors. Other sensors, including diodes, are supported by DC constant-current excitation.

Sensor type ACR indicates an AC resistor sensor that uses constant-voltage bias. Here, the Bias Voltage field will show selections of 1.0, 10.0mV, 3.3mV and 1.0mV to indicate the voltage that is held on the sensor. The Model 9302/9304 has an autoranging current source that will maintain the selected voltage.

For sensor types other than ACR, the Bias Voltage field will show N/A for not applicable.

Additional information on excitation voltages and currents is given in the section "Input Channels".

Setting a Temperature Alarm

The Alarm lines are used to setup alarm conditions. The Model 9302/9304 allows alarm conditions to be assigned independently to any of the input channels.

High temperature, low temperature and sensor fault alarms may be entered and enabled or disabled. Note that there is a 0.25K hysteresis in the assertion of high and low temperature alarms.

Alarm conditions are indicated on the front panel by the Alarm LED and (if enabled). They are also reported via the remote interfaces.

Pressing the ◀ key will return to the Root Menu.

The Analog Output Menu

The Model 9302/9304's analog output is programmed from this menu. It is selected from the Root Menu.

Analog Output Menu			
1	**Channel: ChA**		Select the controlling input source channel.
2	**Analog Enable: Yes**		Enable the analog output. Selections are Yes or No.
3	**Offset: 300.000**	#	Offset temperature.
4	**Gain: 0.50000**	#	Gain, unit-less.

Table 21: Analog Output Setup Menu

Setting the Analog Output

The first line of the Analog Output Menu selects the source input channel. The analog output voltage will be scaled to the selected channel.

Next is the enable. If the analog output is not enabled, it will output a constant zero Volts.

The Offset and Gain values are used to scale the output to be within it's zero to 10 Volt range. The formula is:

$$Output = (Temperature - Offset) \times Gain$$

Where *Temperature* is the current reading of the selected input channel.

The Relays Menu

There are two dry-contact relays available in the Model 9302/9304. They can be independently programmed by using this screen. The relay number, 1 or 2, is superscripted in the first column.

Relay #1, Relay #2 Setup Menu			
1	**1 High:**	**200.000 #**	Set point for the High Temperature relay.
2	**1 High Enable:**	**No**	High temperature relay enable. Selections are Yes or No.
3	**1 Low:**	**200.000 #**	Set point for the Low Temperature relay.
4	**1 Low Enable: Yes**		Low temperature relay enable. Selections are Yes or No.

Table 22: Relay Setup Menu

Setting up a Relay

The various conditions that can cause a relay to assert may be enabled or disabled by using the Enable fields provided.

High and Low temperature set points are entered as floating point numeric values. There is a 0.25K hysteresis between the asserted and de-asserted states.

The System Setup Menu

The System Functions Menu is used to set many of the instrument's parameters including display resolution, I/O port settings etc. It is selected from the Root Menu.

System Functions Menu			
1	**DisplyTC: 2S**	◣	Sets the display time constant in seconds. Selections range from 0.5S to 16S
2	**DisplyRS: 3**	◣	Sets the resolution. Selections are: 1, 2, 3 or Full.
3	**RS232: 9600**	◣	Selects the RS-232 baud rate.
4	**Data Log: Off**	◣	Start or stop data logging to an internal buffer.
5	**Data Log: 5 sec**	#	Internal data logging interval.
6	**Data Log Cnt: 195**	#	Current log count
7	**Erase Data Log** ■		Erase internal data logging buffer.

Table 23: System Functions Menu

Display Time Constant

The first line of the System Functions Menu is Display TC, Or, Display time constant. This is an enumeration field that sets the time constant used for all temperature displays. Choices are 0.5, 1.0, 2.0, 4.0, 8.0 and 16.0 Seconds.

The time constant selected is applied to all channels and is used to smooth data in noisy environments.

Display Resolution

The Display Resolution line (Display:RS) is used to set the temperature resolution of the front panel display. Settings of 1, 2 or 3 will fix the number of digits to the right of the decimal point to the specified value. A setting of FULL will left justify the display in order to show the maximum resolution possible.

RS-232

RS232 Rate is an enumeration of the RS-232 baud rate. Choices are 9600, 19,200 38,400 and 57,600.

> ※ **NOTE:** Changing the RS-232 baud rate will result in an instrument reset. When reset is complete, the selected baud rate will be used.

Data Logging

The next four fields are used to configure internal data logging. Logging is turned off or on by using the Data Log: field. This will start or stop recording all input channel data to an internal non-volatile memory.

The data-logging interval, in seconds, is set by the next field.

The Data Log Cnt: field is display-only and shows how many samples there are in the log buffer.

The Erase Data in Log field is selected to erase the internal log memory. Press **Enter** to begin the erasure sequence. The unit will then request confirmation.

Data accumulated into the log may be read out by using the utility software, or by use of remote commands.

The Network Configuration Menu

The Network Configuration Menu is accessed from the System Setup Menu. It is used to configure basic Ethernet LAN settings. For advanced network settings, use a web browser to view the embedded web server.

Network Configuration Menu			
1	**IP = 192.168.0.4**	●	Press **Enter** to change the unit's Ethernet IP address.
2	**Reset Net Config**	●	Press **Enter** to reset all Ethernet LAN settings back to their original factory defaults.s

The Time / Date Setup Menu

The Time / Date Setup Menu is used to set the system's time and date settings.

Time / Date Setup Menu			
1	**Time: 11:04:03**	●	Enter time in 24 hour format.
2	**Date: 7/1/05**	●	Enter Date
3	**Daylight: No**	↘	Enable automatic daylight savings compensation.

The Model 9302/9304 Web Site

The Status Page

The Home, or Status Page is shown here:

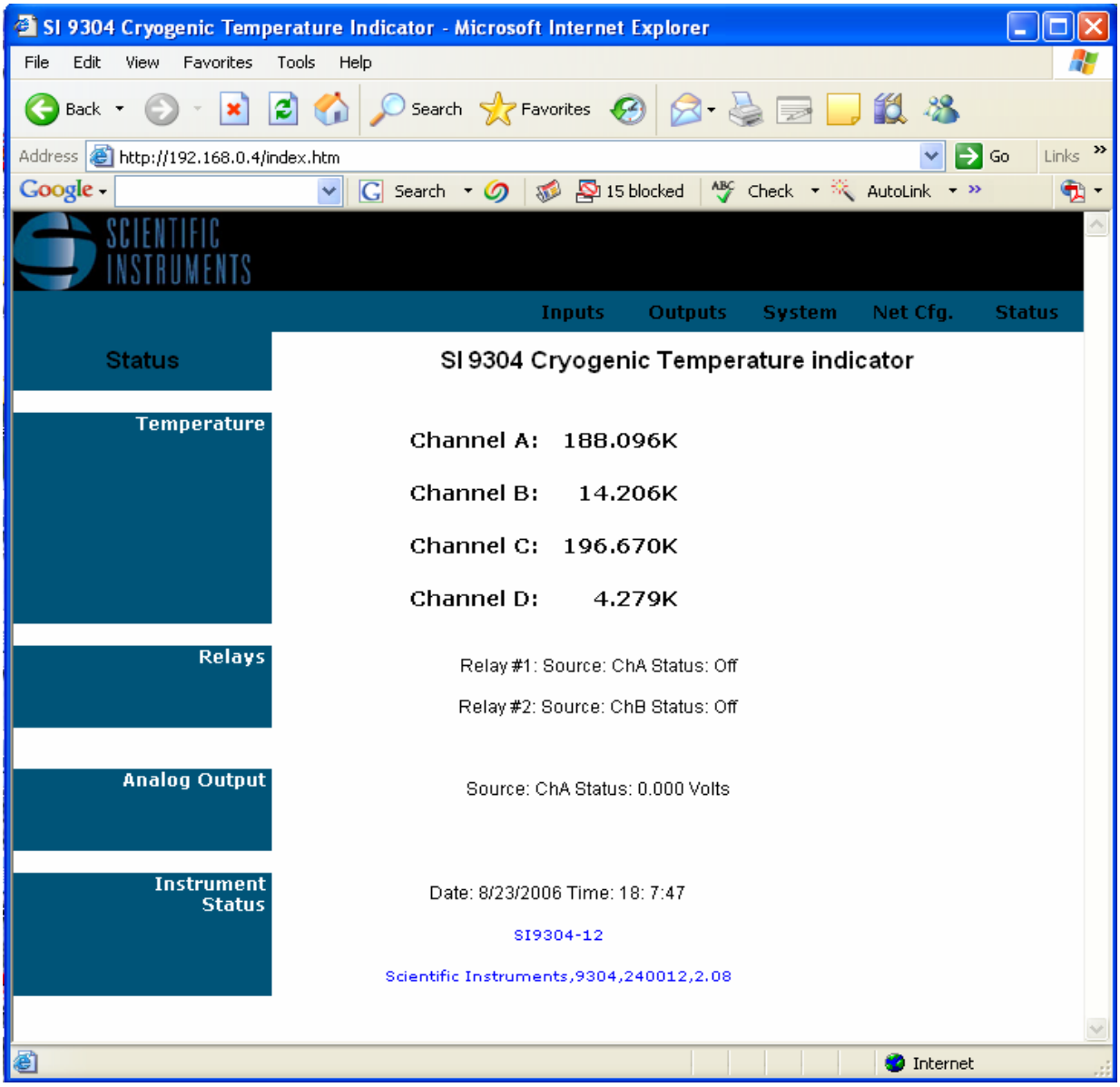


Figure 7: Model 9302/9304 Web Site Status Page

This page shows the current temperature and alarm conditions for both channels as well as the status of both relays and the analog output. Clicking on the Status field of the top navigation bar will refresh this page.

The Network Configuration page

The Network Configuration page is accessed by clicking on the Net Config. field of the top navigation bar.

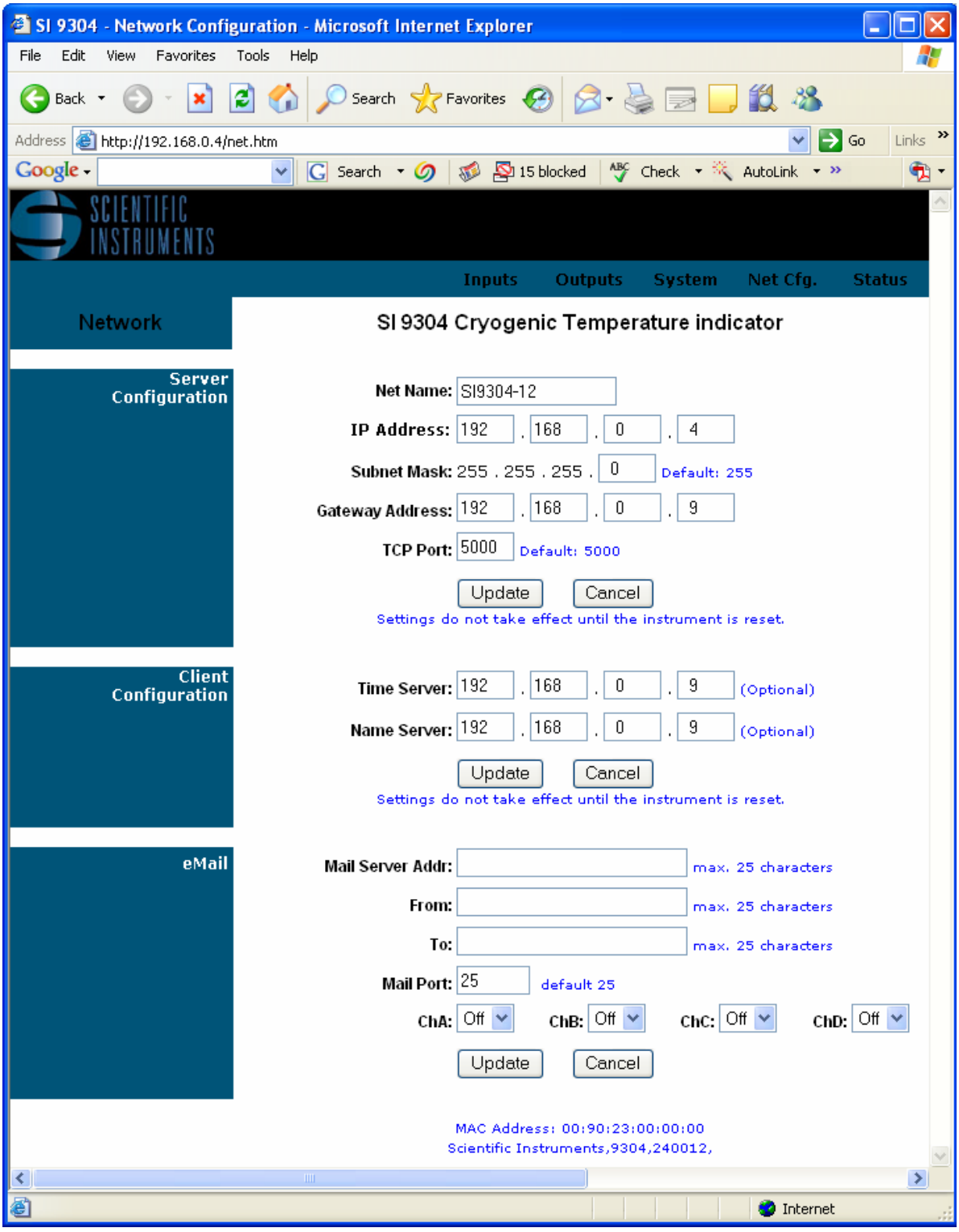

SI 9304 - Network Configuration - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.0.4/net.htm
Go Links
Google Search 15 blocked Check AutoLink
SCIENTIFIC INSTRUMENTS
Inputs Outputs System Net Cfg. Status
Network
SI 9304 Cryogenic Temperature indicator
Server Configuration
Net Name: SI9304-12
IP Address: 192 . 168 . 0 . 4
Subnet Mask: 255 . 255 . 255 . 0 Default: 255
Gateway Address: 192 . 168 . 0 . 9
TCP Port: 5000 Default: 5000
Update Cancel
Settings do not take effect until the instrument is reset.
Client Configuration
Time Server: 192 . 168 . 0 . 9 (Optional)
Name Server: 192 . 168 . 0 . 9 (Optional)
Update Cancel
Settings do not take effect until the instrument is reset.
eMail
Mail Server Addr: max. 25 characters
From: max. 25 characters
To: max. 25 characters
Mail Port: 25 default 25
ChA: Off ChB: Off ChC: Off ChD: Off
Update Cancel
MAC Address: 00:90:23:00:00:00
Scientific Instruments,9304,240012,
Internet

Figure 8: Network Configuration Page

This page is used to set the network parameters for the Model 9302/9304. These parameters are modified by entering new data and clicking on the Submit button.

Note that, if you change settings on this page, the Model 9302/9304 will reset to the new configuration and disconnect from your web browser. You will need to enter a new address in the browser to re-connect.

Configuring the Network Connection

The Network Name is optional and is used as a convenience to identify a specific instrument. The factory default is SI9304 + the last four digits of the unit's serial number.

The IP address and subnet mask default to: 192.168.0.4 and 255.255.255.0. These should be changed so that the unit is on the same IP segment as the user's network. This means that the first three fields of the IP should match the user's network and the last field should be unique to the unit.

Configuring E-mail

E-mail is configured from this page. First, a SMTP mail server address must be entered. For example: smtp.mymailhost.com.

Next is a 'from' and a 'to' E-mail address. Note that the 'from' address must be valid on the specified mail server.

The 'Mail Port' is usually port 25.

Finally, select the channels that you want to receive E-mail for. Mail will be sent whenever an enabled channel asserts an alarm condition.

Alarm conditions are setup on the Input Channel Configuration page.

> ※ **NOTE:** If you are connecting the Model 9302/9304 to a Local Area Network with a gateway to the Internet, there must be an e-mail server program running on the gateway computer. Unlike sending e-mail from a computer, the Model 9302/9304 is an 'Internet Appliance' that requires a local e-mail server to forward e-mail.
>
> E-mail server programs are commonly available. Check with your systems administrator for details.

The Input Channel Configuration Page

This page is used to set the characteristics of each input channel including sensor type, units and alarm conditions.

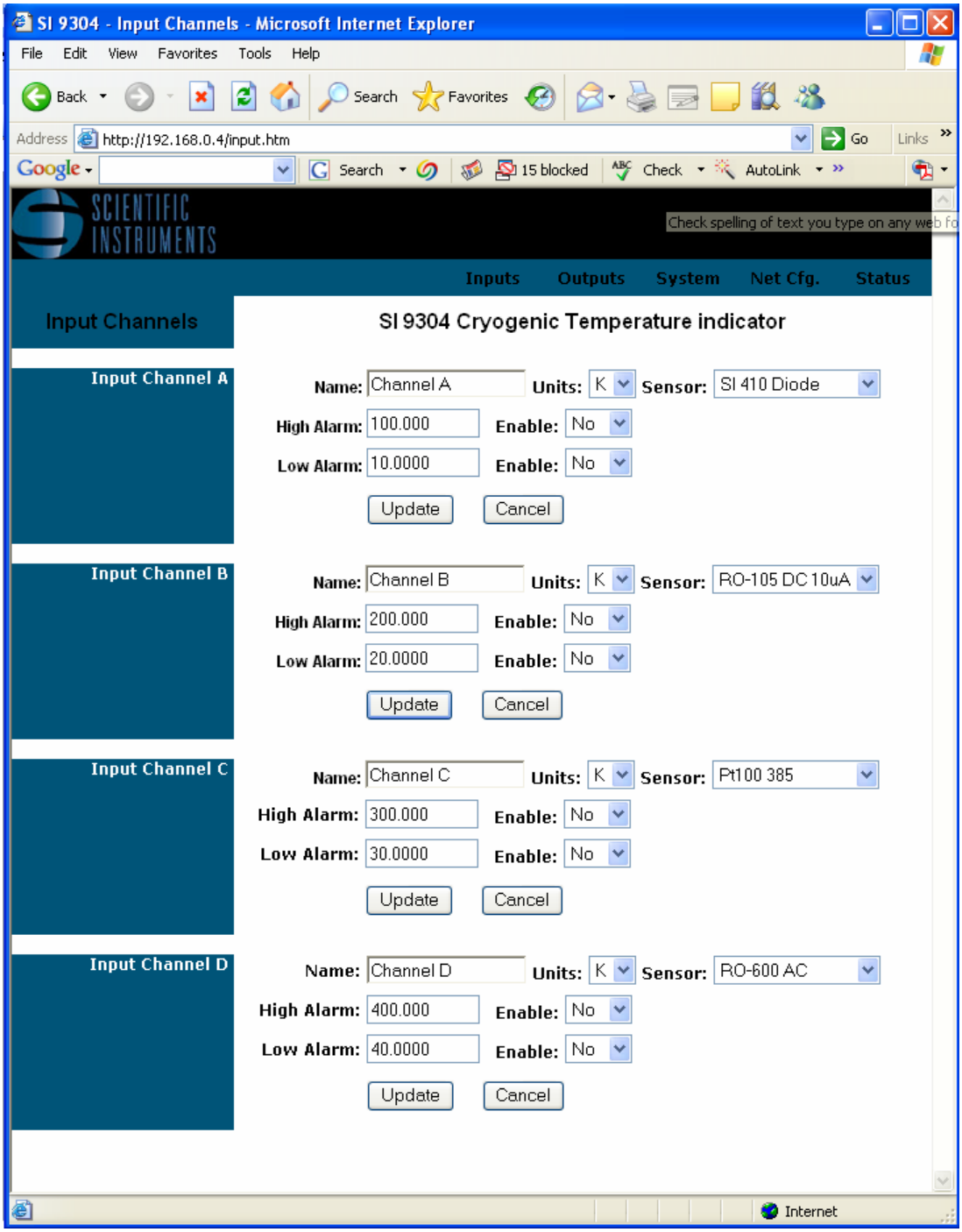

SI 9304 - Input Channels - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites
Address http://192.168.0.4/input.htm
Go Links
Google Search 15 blocked Check AutoLink
SCIENTIFIC INSTRUMENTS
Check spelling of text you type on any web fo
Inputs Outputs System Net Cfg. Status
Input Channels
SI 9304 Cryogenic Temperature indicator
Input Channel A
Name: Channel A Units: K Sensor: SI 410 Diode
High Alarm: 100.000 Enable: No
Low Alarm: 10.0000 Enable: No
Update Cancel
Input Channel B
Name: Channel B Units: K Sensor: RO-105 DC 10uA
High Alarm: 200.000 Enable: No
Low Alarm: 20.0000 Enable: No
Update Cancel
Input Channel C
Name: Channel C Units: K Sensor: Pt100 385
High Alarm: 300.000 Enable: No
Low Alarm: 30.0000 Enable: No
Update Cancel
Input Channel D
Name: Channel D Units: K Sensor: RO-600 AC
High Alarm: 400.000 Enable: No
Low Alarm: 40.0000 Enable: No
Update Cancel
Internet

Figure 9: Input Channel Setup Web Page

The Output Channel Configuration Page

Output channels on the Model 9302/9304 include two dry-contact relays and an analog output. These may be completely configured using this web page. System Configuration Page

From the System Configuration page, temperature displays and data logging is configured.

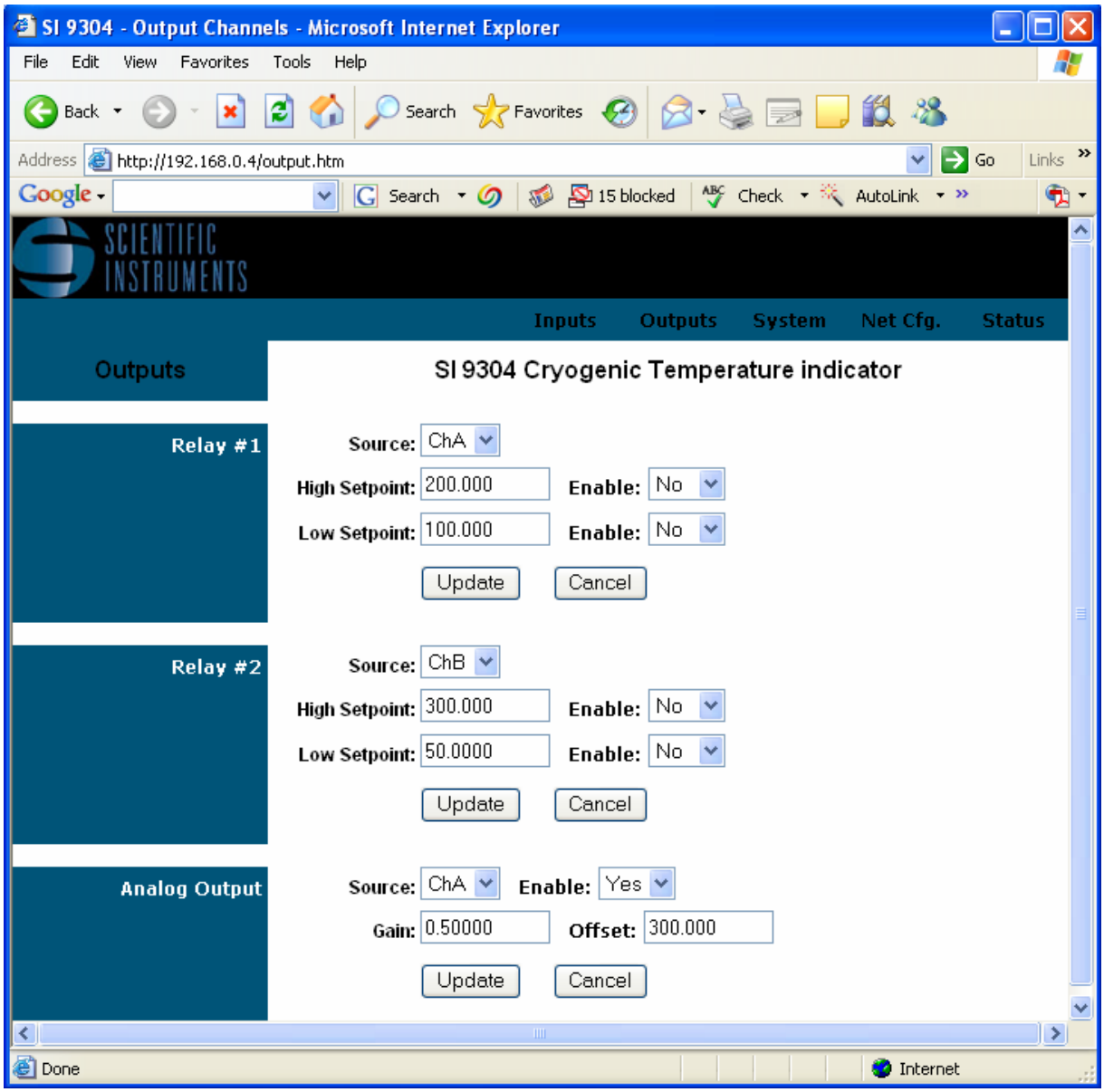


Figure 10: Output

System Configuration Page

From the system configuration page, temperature displays and data logging is configured.

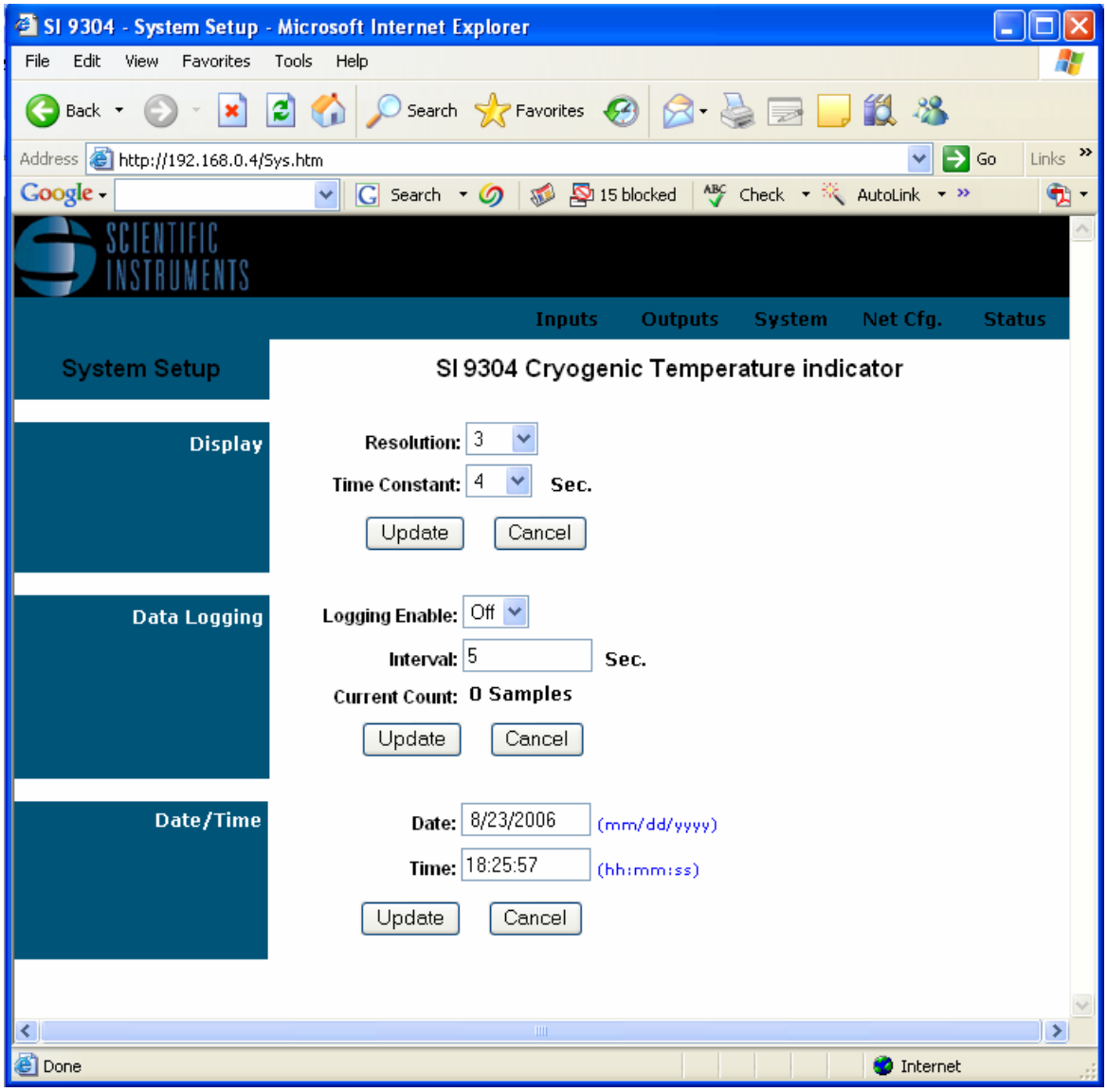


Figure 11: System Configuration Page

The Resolution field is used to select the number of significant digits to the right of the decimal point for all temperature displays. Choices are 1, 2, 3 or Full. Selection of Full will left justify temperature displays for the maximum display width.

Time constant is an averaging filter that can be applied to temperature displays. It is in units of seconds.

The internal data logging capability can be configured from the Data Logging form. When enabled, internal logging will proceed continuously at the selected interval.

Utility Software

Utility software can be used to control and configure the instrument via the RS-232, LAN, USB or IEEE-488 interface. It runs under all versions of the Windows operating system. This software provides several useful functions, including:

1. Real-time strip charts of temperature.
2. Data Logging. This function allows the user to record data from the instrument at a specified sample rate. The resulting file is compatible with most spreadsheet and data analysis software.
3. Download or upload sensor calibration curves. The software will accept curves in Cryo-con .CRV, Lakeshore .340 or Scientific Instrument's .txt format. In fact, it will read almost any table of temperature vs. sensor units.
4. CalGen™ function is implemented. This function allows the user to fit an existing sensor calibration curve to one- two- or three user-specified points. The result is a high accuracy sensor calibration at low cost.
5. Upload and download PID tables to a temperature controller. These tables can be generated by using a simple text editor and downloaded to the controller.
6. Configuration of any of the instrument's remote interfaces.
7. 'Interactive Mode' provides interactive communication with the instrument over any of the remote interfaces.
8. Instrument calibration using a simple step-by-step menu driven process.

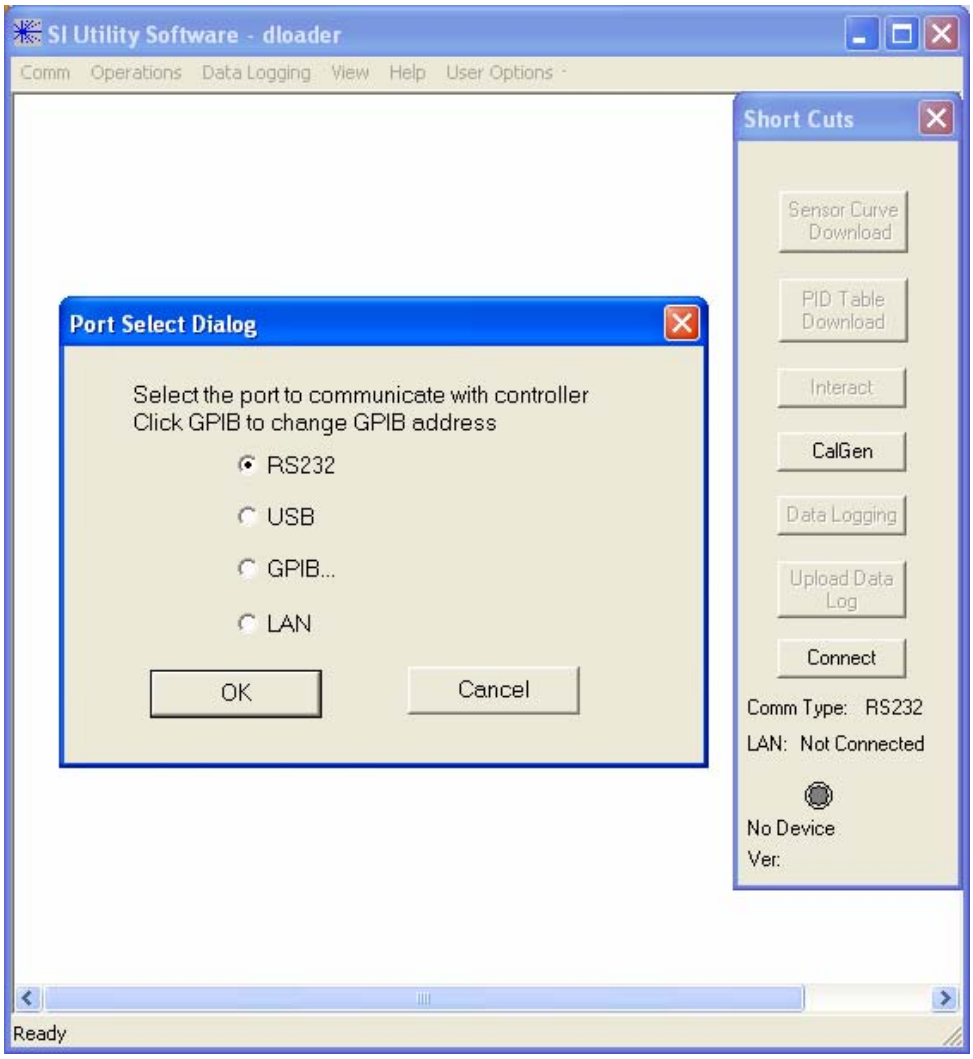
Installing the Utility Software

From a CD, the utility software package does not require installation. It can be executed from the CD directly by running the UTILITY.EXE program.

When the software is downloaded off of the Internet, it is in a self-extracting ZIP format and must first be un-zipped onto hard disk.

Connecting to an Instrument

The desired remote interface connection may be selected by clicking **Comm>Port Select** from the main menu.



Select the desired communications port and then click **OK**..

Click on the **Connect** button of the shortcut menu bar or on **Comm->Connect** from the main menu to connect to the instrument.

After a short delay, the connect LED should light and the instrument type will be displayed. Also, most of the grayed-out fields on the menu bars should activate.

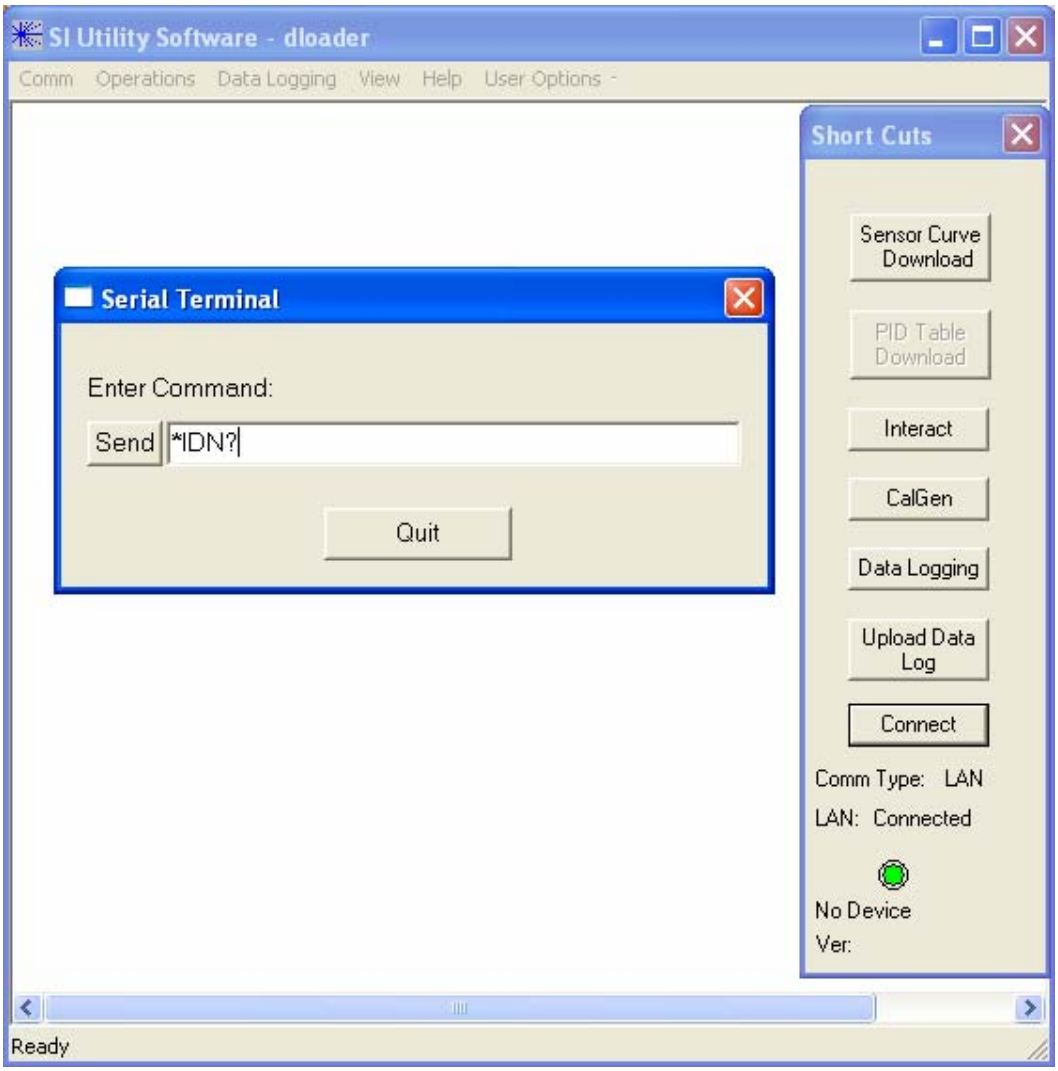
Using the Interactive Terminal

The Utility Software's Interactive Terminal mode allows the user to send commands to the instrument and view the response.

Terminal mode is selected by selecting **Comm>Interact** from the main menu or **Interact** from the shortcut bar. This will result in the display shown below.

To interact with the instrument, type a remote command into the dialog box and click **Send**. The command will be transmitted to the instrument and a response, if any, will be displayed on the background window.

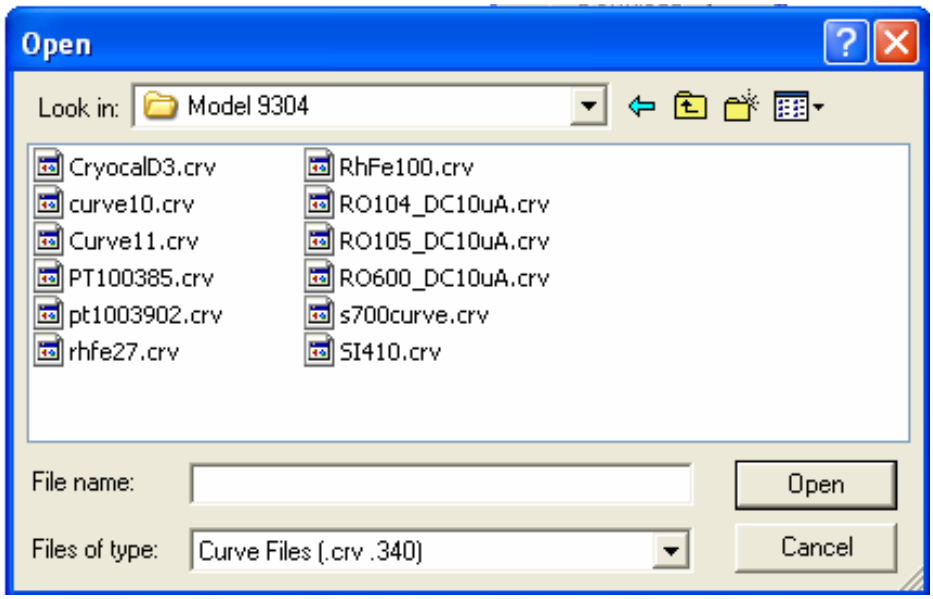
To exit terminal mode, click the **Quit** button on the dialog box.



Downloading or Uploading a Sensor Calibration Curve

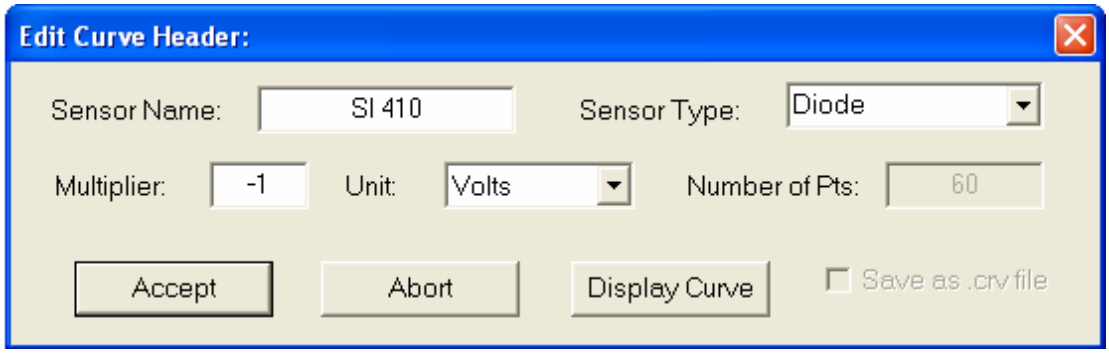
Sensor calibration curves may be transferred between the PC and the instrument by using the Calibration Table menu.

To download a curve (send it from the PC to the instrument), either select “Sensor Curve Download” from the shortcut bar or **Operations>Sensor Curve>Download** from the main menu. This will cause a file selection dialog box to appear as follows:



From this screen, the desired calibration curve is selected. Cryo-con calibration curves have the file extension of .CRV. Lakeshore curves with the extension .340 may also be selected. Scientific Instruments .txt files may be downloaded by first selecting a file type of *.* and then selecting the desired calibration curve file.

After selecting the file and clicking on **Open**, the selected file will be read and the Edit Curve Header dialog box will appear. This box contains information extracted from the curve file header that can be modified, if desired, before the curve is downloaded.



“Sensor Name” is any 15-character string and is only used to identify the sensor.

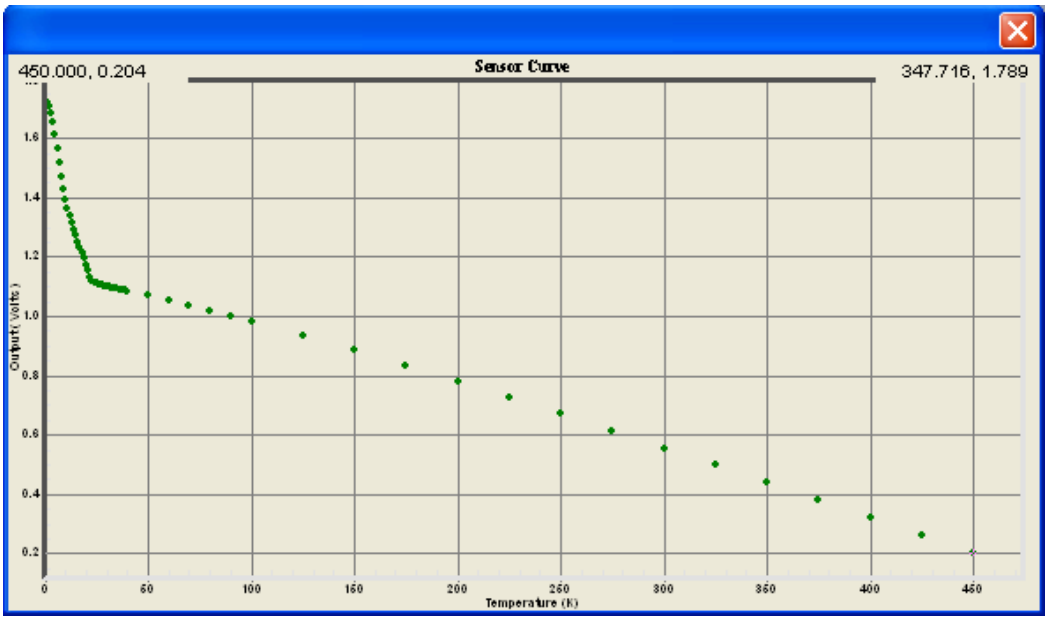
Sensor type can be selected from a pull-down menu or entered directly. Note that different models of SII instruments support different types of sensors. Therefore, it is important to enter a sensor type that is supported by the specific product. If the instrument receives a sensor type that it does not support, the ‘Diode’ type is selected. The section titled “Supported Sensor Configurations” gives complete information on sensor types.

The Multiplier field is used to select the sign of the sensor’s temperature coefficient. A value of –1 selects a Negative-Temperature-Coefficient sensor while a value of 1 selects a Positive-Temperature-Coefficient.

The Unit field selects the units used in the calibration curve. Choices are: Volts, Ohms or LogOhm.

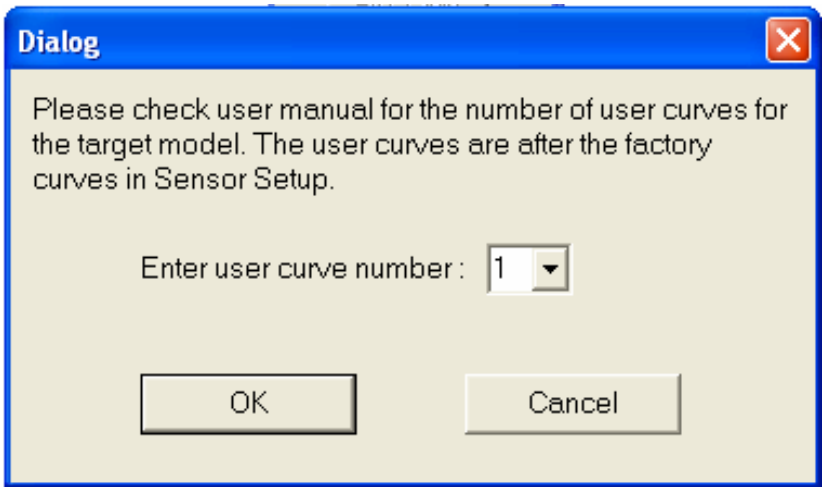
Checking the ‘Save as .crv’ will save the curve to disk as a Cryo-con .crv file.

The sensor curve may be viewed as a graph by clicking the ‘Display Curve’ button. An example plot is shown here:

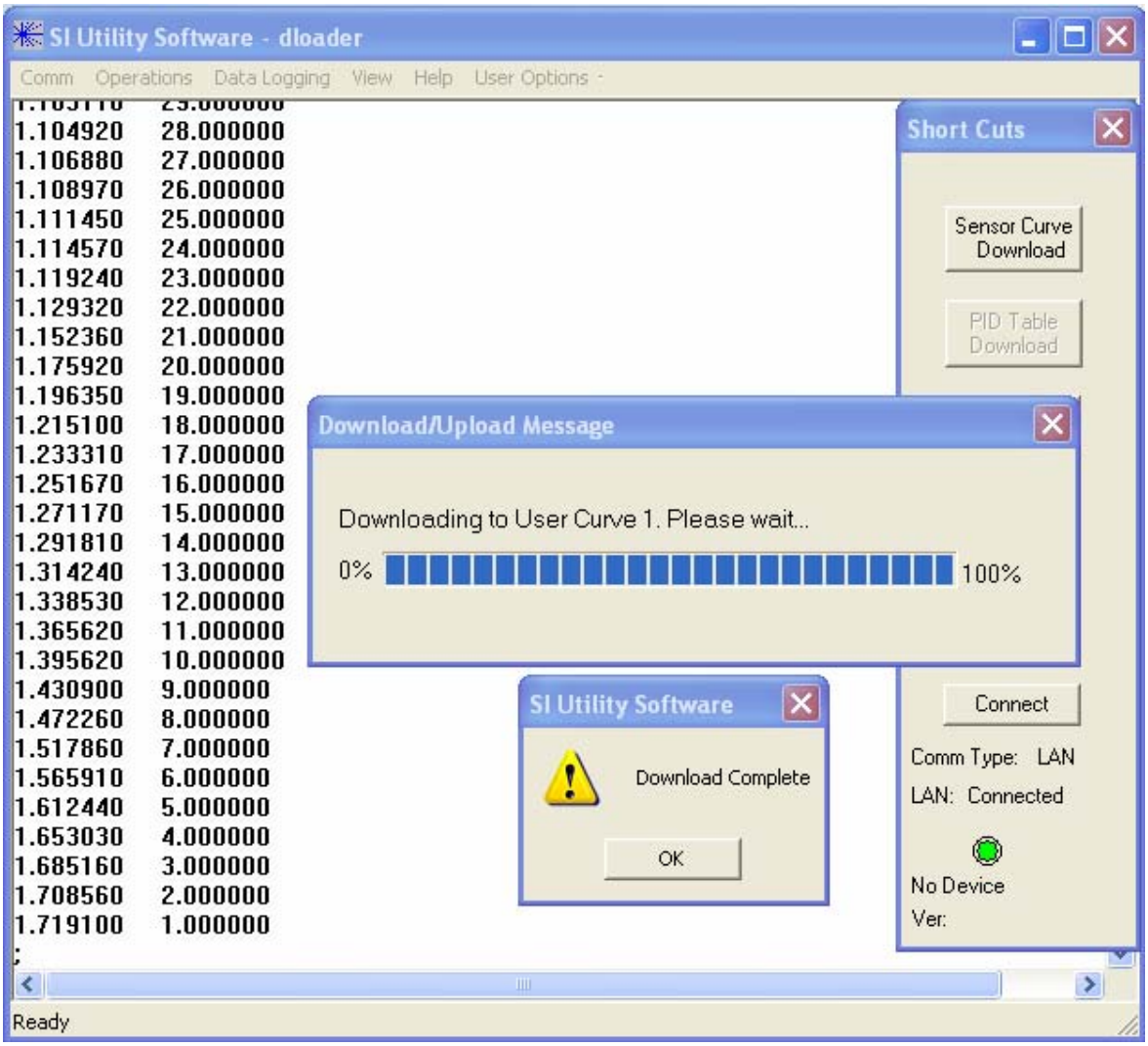


After completing any desired changes in the “Edit Curve Header” dialog box, click ‘Accept’ to proceed. Then the, curve number dialog box will appear:

A user calibration curve should be entered here. For the Model 9302/9304, user curves are 1 through 4.


Dialog
Please check user manual for the number of user curves for the target model. The user curves are after the factory curves in Sensor Setup.
Enter user curve number :
1
OK
Cancel

When 'OK' is selected, the sensor calibration curve will be downloaded to the instrument. During the transfer, curve data points will be displayed in the window's main pane. Upon completion, the Download Complete dialog box will appear:



Dismiss this dialog box to complete the download process.

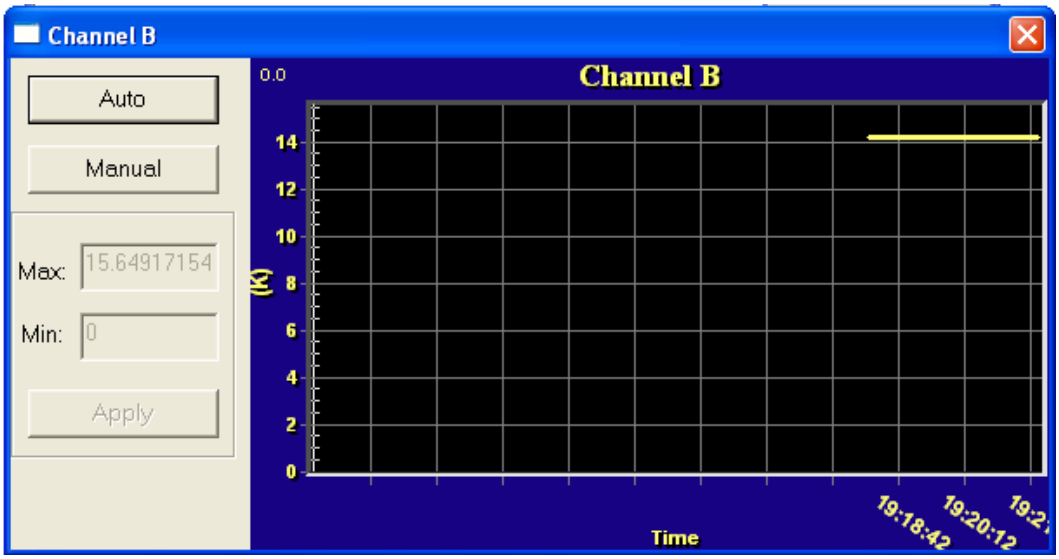
To upload a calibration curve, use the same procedure and select **Upload**. This will transfer a curve from the instrument to the PC.

Using the Real-Time Strip Charts

The real-time strip chart feature of the Utility Software lets the user continuously display any combination of input channels on the computer display.

This function is initiated by selecting the **View** command on the Utility Software's main toolbar, then selecting the desired channels to monitor.

A strip chart will be displayed for each channel selected. The dialog box will show the channel's Input Identifier, Name String and a chart of current temperature.

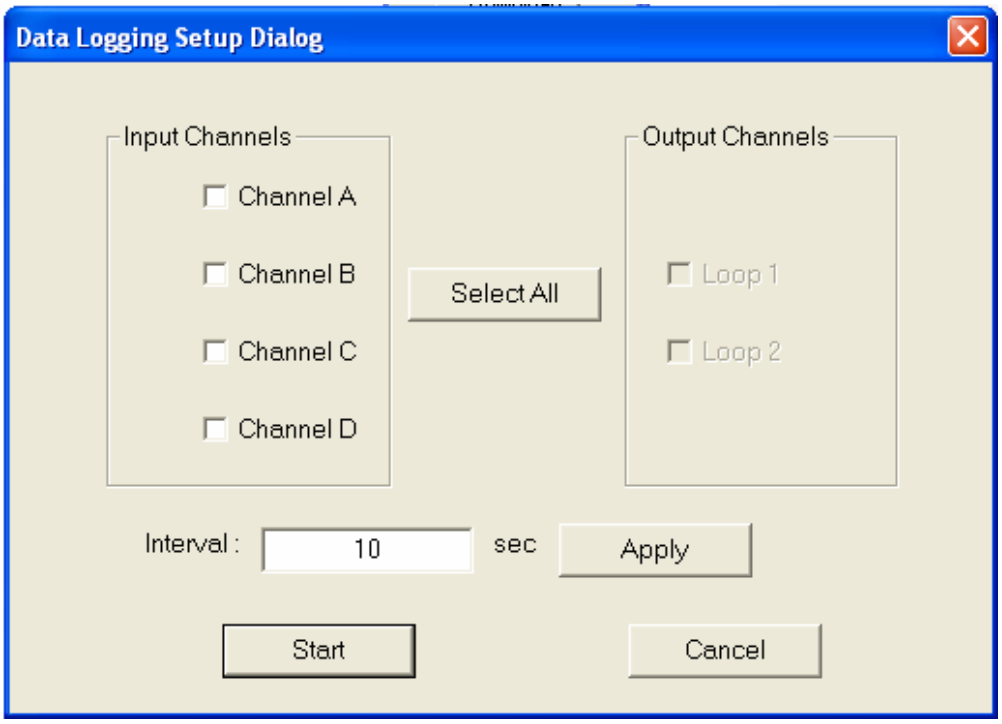


The update rate of the chart is locked to the program's Data Logging Interval. The section below details how to set this value.

Data Logging

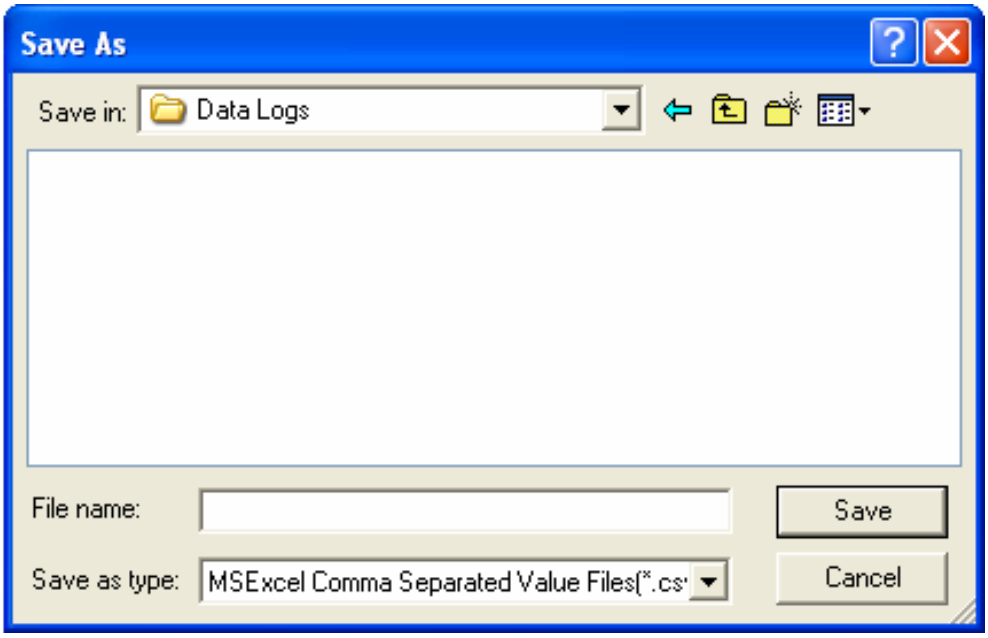
The Utility Software will perform data logging on all of the instruments input and control output channels. The result is a disk file in Comma-Separated-Value, or CSV format. This format is compatible with any data analysis or charting software including Microsoft Excel.

To initiate data logging, select the **Data Logging** button from the Utility Software's main menu. The Data Logging Setup dialog box will now appear.



On this dialog box, check the desired channels and set an Interval value in Seconds. The minimum interval is 0.1 Second.

When the **Start** button is clicked, a file selection dialog box will be shown.



From this dialog box, enter a file name and select the directory where data logging results will be saved.

As soon as the **Save** button is clicked, the software will begin continuous data logging to the specified file.

While data logging is in progress, a dialog box will be displayed that allows the user to stop logging. When this **Stop** button is clicked, logging is stopped and the log file is closed.

CalGen™ Calibration Curve Generator.

The CalGen™ feature is used to generate new calibration curves for Silicon Diode or resistor sensors. This provides a method for obtaining higher accuracy temperature measurements without expensive sensor calibrations.

New Curves can be generated from any user selected sensor calibration curve and are written to a specified file.

For Diode sensors, the user may specify one, two or three data points. CalGen™ will generate the new curve based on fitting the input curve to the user specified points.

Platinum or other resistor calibration curves require one or two data points. The generated curve will be a best fit of the input curve to the two specified input points.

Since CalGen™ fits a sensor calibration curve to measured data, any errors in the instrument's measurement electronics are also effectively cancelled.

CalGen™ Initial Setup

To start the CalGen™ process, either select **CalGen™** from the shortcut bar, or select Operations>CalGen from the main menu. This will initiate the process of generating a new sensor curve.

Using CalGen With Diode Sensors

Options for generating Diode calibration curves are:

1. One point near 300K. The portion of a Diode Sensor curve above 30K will be fit to a user-specified point near 300K. This is a two-point fit where the 30K point is taken from the existing calibration curve. The portion of the curve below 30K is unaffected.
2. Two points: 300K and 77K. Here, two user-specified points are taken to fit the diode curve region above 30K. The entire curve is offset to match the 77K point, then, the >30K region is fit to the two points.
3. Three points: 300K, 77K and 4.2K. Two points above 30K are fit as in the selection above. Then, a third point is used to fit a single point in the high-sensitivity region below 20K.
4. One point near 4.2K. This is a two-point fit where the 20K point is taken from the existing calibration curve. The portion of the curve above 20K is unaffected.

Using CalGen™ With Resistor Sensors

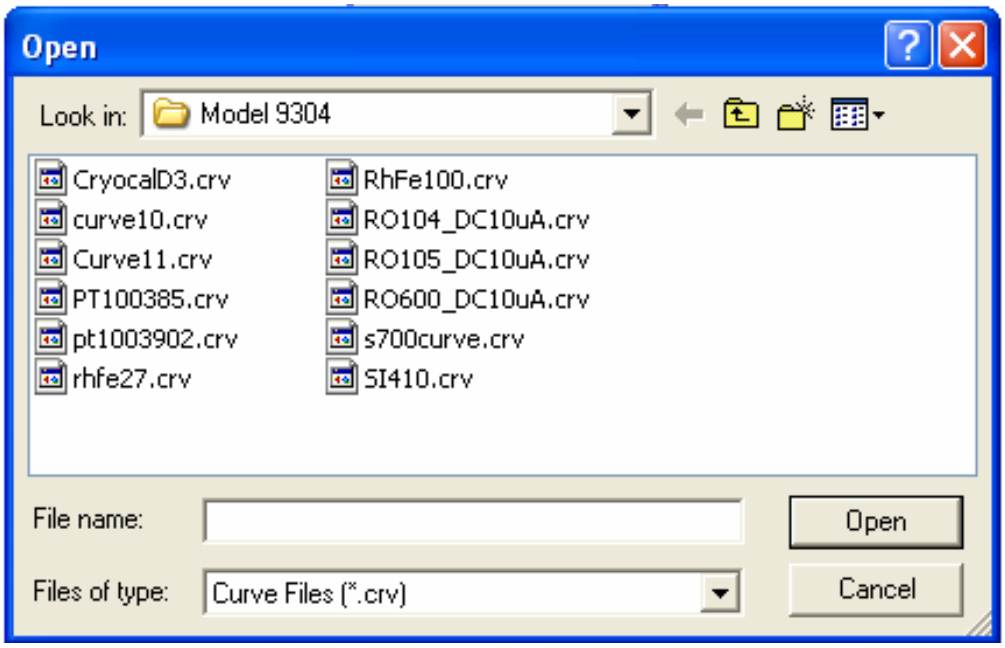
The calibration curve generation procedure for Platinum or other resistor sensors is the same as for the diode. However, these sensor curves are generated using two user specified points. Therefore, the selection of the number of points is not required.

Example CalGen™ Procedure

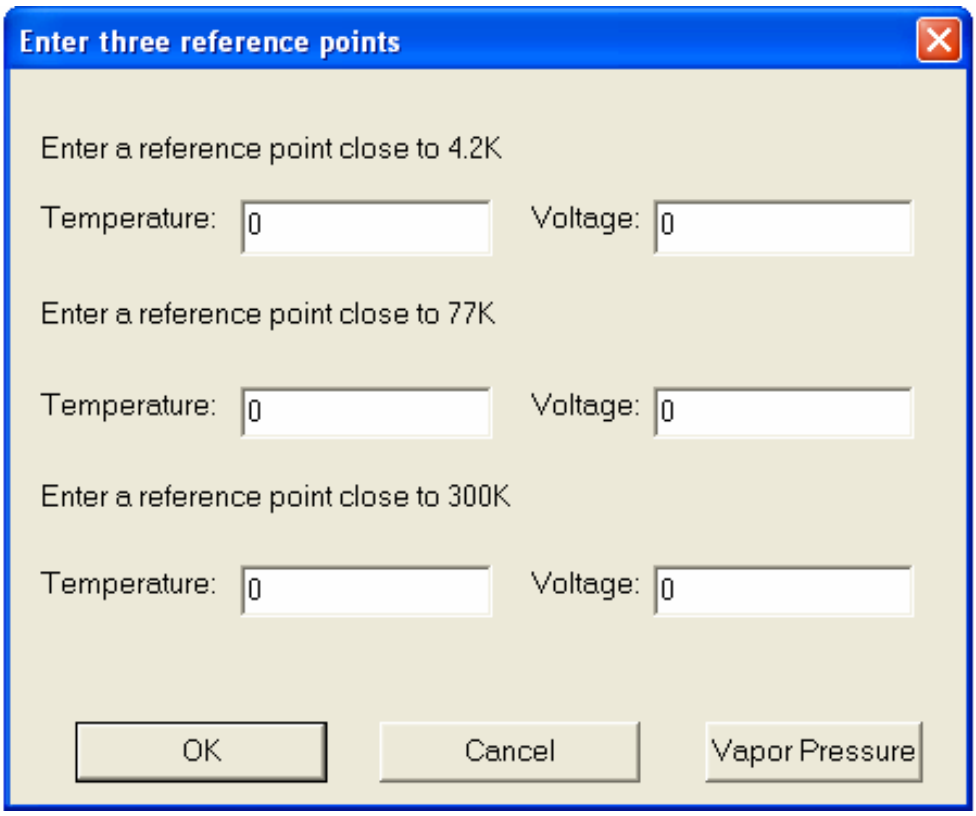
A complete procedure for calibrating a diode sensor at three points is shown here. Before the procedure can be started, the instrument must be connected and have a valid sensor connected.

The CalGen™ procedure will require the user to stabalize the input temperature at three user-selected points. It will capture data at each of these points and then generate a new curve from that data.

When a 3-point CalGen is started for a Silicon Diode sensor, the reference curve must first be selected. This is the curve that will be rotated and shifted to fit the selected points.


Open
Look in:
Model 9304
CryocalD3.crv
curve10.crv
Curve11.crv
PT100385.crv
pt1003902.crv
rhfe27.crv
RhFe100.crv
RO104_DC10uA.crv
RO105_DC10uA.crv
RO600_DC10uA.crv
s700curve.crv
SI410.crv
File name:
Open
Files of type:
Curve Files (*.crv)
Cancel

When the curve has been selected, the following dialog box will appear:



The process requires you to completely fill out this dialog box by selecting a temperature and then copying the voltage (or resistance) reading corresponding to that temperature from the instrument.

Note that the Vapor Pressure button will take the user to a convenient calculator that will compute the temperature of various cryogens from the current barometric pressure.

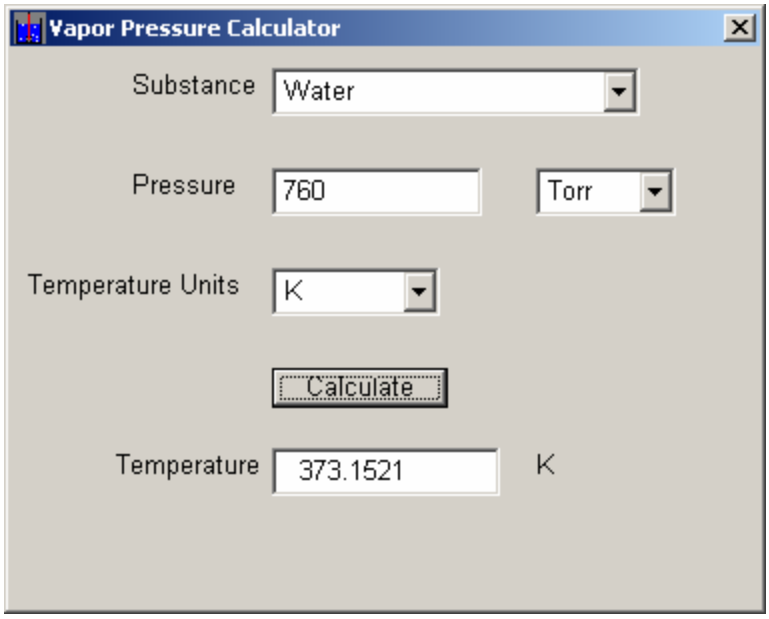
Once the dialog box has been completed, click OK to proceed.

To finish the process, you will be prompted to save the modified calibration curve to a file.

The Vapor Pressure Calculator.

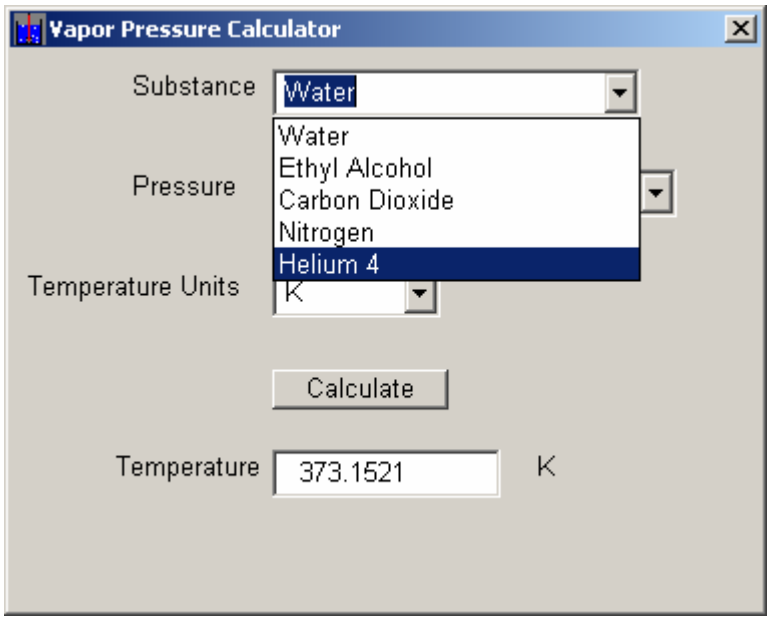
The Vapor Pressure Calculator is a convenient aid that computes the actual temperature of most cryogens given the current barometric pressure. It can be launched directly off of the utility disk by executing “Vapor Pressure Calculator.exe” or from the CalGen™ dialog as shown above.

A typical calculation is shown here:



You must select the Substance from a drop-down list and then select the barometric pressure and temperature units.

Substance selections are shown here:



Instrument Calibration

Calibration of the Model 9302/9304 requires the use of various voltage and resistance standards in order to generate calibration factors for the many measurement ranges available.

Calibration is 'Closed-Case'. There are no internal mechanical adjustments required. The Model 9302/9304 cannot be calibrated from the front panel.

Calibration data is stored in the instrument's non-volatile memory and is accessed only via the remote interfaces. Calibration of a measurement range is the simple process of generating an offset and gain value. However, since there are several input ranges available on each sensor input, the process can be time consuming.

Caution: Any calibration procedure will require the adjustment of internal data that can significantly affect the accuracy of the instrument. Failure to completely follow the instructions in this chapter may result in degraded instrument performance.
The utility software used in this procedure will first read all calibration data out of the instrument before any modifications. It is good practice to record these values for future reference and backup.

Calibration Services

When the controller is due for calibration, contact Scientific Instruments, Inc. for low-cost recalibration. The Model 9302/9304 is supported on our automated calibration systems which allow SII to provide this service at competitive prices.

Calibration Interval

The Model 9302/9304 should be calibrated on a regular interval determined by the measurement accuracy requirements of your application.

A 90-day interval is recommended for the most demanding applications, while a 1-year or 2-year interval may be adequate for less demanding applications. SII does not recommend extending calibration intervals beyond 2 years.

Whatever calibration interval you select, SII recommends that complete re-adjustment should always be performed at the calibration interval. This will increase your confidence that the instrument will remain within specification for the next calibration interval. This criterion for re-adjustment provides the best measure of the instrument's long-term stability. Performance data measured using this method can easily be used to extend future calibration intervals.

Minimum Required Equipment

All calibrations require a computer with an RS-232 or IEEE-488 connection to the instrument. Additionally, reference standards are required for each input range as follows:

- The Silicon Diode input range (Calibration Type I10UA and V10UA) requires voltage references of 0.5 and 1.5 Volts DC and a resistance standard of 100KΩ.
- The Constant-Voltage AC resistance ranges (Type AC10UA, AC100UA and AC10UA) require the use of 100KΩ, 10KΩ, 1KΩ, 100Ω and 10Ω resistances.
- The 100Ω Platinum range (Type R1MA) requires a 100Ω and a 10Ω resistor.
- The 1000Ω range (Type R100UA) requires 1K Ω and 100 Ω resistors.
- The 10,000Ω range (Type R10UA) requires 10KΩ and 1KΩ resistors.

The test equipment recommended for complete calibration is a Fluke 5700A DMM calibrator.

The Basic Calibration Sequence

You must first connect the Model 9302/9304 to a computer via the RS-232 (Serial) or LAN interface and then run the Utility Software provided with the controller. The Utility Software must be version 7.4.2 or higher.

From the start-up menu of the Utility Software, click the Connect button in the bottom of the Short Cuts toolbar. The software will connect to the instrument and display the connection status below the button.

In case of an error, please correct the port connection settings and try again.

From the main menu, select Operations->Unit Cal. The program will read the current calibration values from the instrument and display a calibration screen as shown below. All calibration operations can be performed by using this screen.

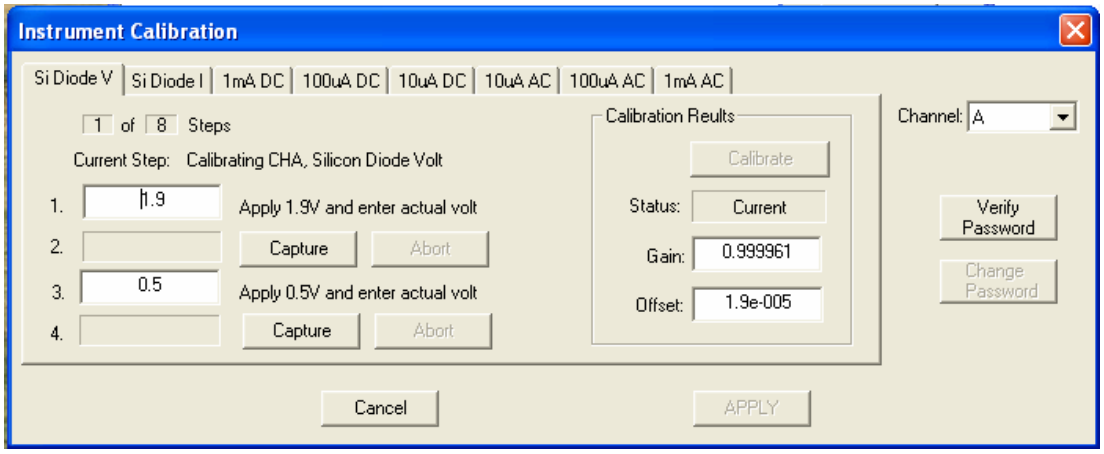


Figure 12: Instrument Calibration Screen

> ※ **Note:** The instrument will require a password before calibration data can be saved. The utility software will allow you to enter and change the password.
>
> The default password is: **SII**

On the far right of the screen, a drop-down box selects the channel to be calibrated. Be sure you have selected the correct channel. In order to perform a complete calibration, you will need to calibrate each channel individually.

Along the top of the screen, there are tabs that show the types of calibration that are supported by the instrument. To perform a complete calibration of a single input channel, all calibration types must be calibrated.

Note the **Calibration Results** box on the screen. The **Status** field will initially be set to 'Current' and the **Gain** and **Offset** values shown will be those read from the instrument.

> ※ **Note:** If your calibration procedure requires saving historical values, you will want to record the Gain and Offset values shown on the initial screen before proceeding with actual calibration.

There are two methods available for calibration:

1. Automatic. The software will recommend voltages and resistances. You can set these values on the input channel and capture the instrument's actual readings. Then, the software will automatically generate offset and gain values for you.
2. Manual: You can manually enter Offset and Gain values and send them to the instrument.

Manual Calibration

To manually calibrate a range, select the desired range from the range type tabs and enter the desired Gain and Offset values in the boxes given and then, click the **APPLY** button.

Gain is a unit-less gain factor that is scaled to a nominal value of 1.0. It is usually computed by:

gain = (UT – LT) / (UM – LM)

where:
UT is the upper target and LT is the lower target.
UM is the upper measurement and LM is the lower measurement.

Gain values greater than 1.2 or less than 0.8 are rejected as out of range.

Offset is in units of Volts or Ohms depending on the calibration type. Nominal value is 0.0. Positive or negative numbers are accepted. It is usually calculated by:

Offset = UT - gain * UM

Automatic Calibration

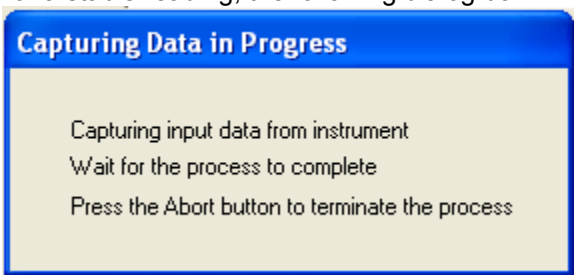
Automatic calibration uses the left-hand side of the calibration screen and is a four-step process:

1. Line 1 requires setting a upper target value on the input channel. Depending on the calibration range selected, this will be in Volts or Ohms.

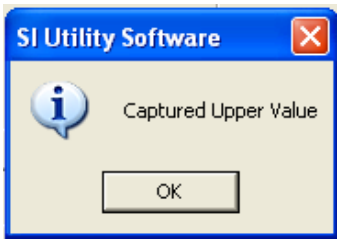
   First, establish a voltage or resistance on the selected input channel that is near the recommended value. Then, enter the actual value in the box provided.

2. Click the Capture button on Line 2. The software will wait for the reading to stabilize and then will capture the reading and display it in the edit box on Line 2.

While waiting for a stable reading, the following dialog box will be displayed:


Capturing Data in Progress
Capturing input data from instrument
Wait for the process to complete
Press the Abort button to terminate the process

When the capture is complete, dismiss the following dialog:



3. Line 3 requires setting a lower target value on the input channel. Depending on the calibration range selected, this will be in Volts or Ohms.

   First, establish a voltage or resistance on the selected input channel that is near the recommended value. Then, enter the actual value in the box provided.

4. Click the Capture button on Line 4. The software will wait for the reading to stabilize and then will capture the reading and display it in the edit box on Line 4.

When the above procedure is complete, you will have established upper and lower target values as well as upper and lower measurements. The edit boxes on lines 2 and 4 will contain the measured values. At this time, you may still change the target values on line 1 and 3 if desired.

Now, you can automatically compute the required gain and offset values by clicking on the **Calibrate** button in the **Calibration Results box**. This will change the **Status** field from 'Current' to 'Calibrated' and will update the **Offset** and **Gain** values with those calculated.

At this point, to values have been transmitted to the instrument!

In order to send the offset and gain values to the instrument's calibration memory, click the **APPLY** button. You will be required to confirm that you really want to update calibration memory.

Summary of Calibration Types

Calibration data must be generated for each input channel by sequencing through the various calibration types on each channel. A summary of types is given here:

Calibration Type	Voltage Range	Output Current	Description
SI DiodeV	0 – 2.5V	N/A	Voltage measurement for use with Silicon Diode temperature sensors.
SI Diode I	N/A	10μA	10μA constant-current source used with Silicon Diode sensors.
1mA AC	10mV, 1.25Hz	Autoranged	1mA range used with constant-voltage mode sensors.
100uA AC	10mV, 1.25Hz	Autoranged	100μA range used with constant-voltage mode sensors.
10uA AC	10mV, 1.25Hz	Autoranged	10μA range used with constant-voltage mode sensors.
1mA DC	0-2.5VDC	1.0mA	DC measurement of 100 Platinum RTD sensors.
100uA DC	0-2.5VDC	100μA	DC measurement of 1K Ohm Platinum RTDs
10uA DC	0-2.5VDC	10μA	DC measurement of 10K Ohm Platinum RTDs or other resistor sensors that use DC current excitation

Calibration of Silicon Diodes

Silicon Diode sensors require the application of a precision 10µA current followed by reading the voltage-drop across the device. Therefore, calibration of a diode requires two steps: 1) Calibration of the input voltage reading and 2) Calibration of the 10µA current source.

Note that the voltage calibration must always be done first since the current source calibration requires a precision voltage reading.

Diode Voltage Calibration

To calibrate the diode voltage range, click on the **SI Diode V** tab and follow the sequence described above to send Gain and Offset values to the instrument.

The upper target requires connection of a 1.9 Volt source. The actual value is between 1.0 Volts and 2.4 Volts. If you do not have a precision voltage source, you can use a 1.5 Volt battery by using a high precision volt meter to measure it's actual voltage.

The lower target requires connection of a 0.5 Volt source. The actual value is between zero Volts and 0.6 Volts. If you do not have a precision voltage source, you can short the input channel for zero volts.

Constant-current Source Calibration

Calibration of the constant-current source is performed by using the **SI Diode I** tab. On this screen, only an upper target value is required since the current-source only requires a gain term.

The upper target requires connection of a 100KΩ resistor. The actual value should be within 10% of 100KΩ.

Calibration of DC resistors

Resistor sensors that use direct current excitation are calibrated by using the **1mA DC**, **100uA DC** and **10uA DC** tabs.

Resistors required for calibration are as follows:

- **1mA DC:** Upper - 100Ω, Lower - 10Ω.
- **100uA DC:** Upper 1,000 Ω, Lower - 100 Ω
- **10uA DC:** Upper - 10,000 Ω, Lower - 1,000 Ω.

Calibration of AC resistors

Resistor sensors that use auto-ranged AC excitation are calibrated by using the **1mA AC**, **100uA AC** and **10uA AC** tabs.

Resistors required for calibration are as follows:

- **1mA AC:** Upper - 100Ω, Lower - 10Ω.
- **100uA AC:** Upper 1,000 Ω, Lower - 100 Ω
- **10uA AC:** Upper - 10,000 Ω, Lower - 1,000 Ω.

Remote Operation

Remote Interface Configuration

The Model 9302/9304 has two remote interfaces: The 10-BaseT Ethernet LAN and the RS-232. Connection to these interfaces is made on the rear panel of the instrument. For specifics about the connectors and cables required, refer to the section above on Rear Panel Connections.

Configuration of the remote interfaces is done at the instrument's front panel by using the Remote I/O Setup Menu.

All configuration information shown on this screen is stored in non-volatile memory and, once setup, will not change when power is turned off or a remote interface is reset.

Ethernet Configuration

Supported Protocols

HTTP: The Hypertext Transfer Protocol is a standard protocol used for transferring information between hosts over TCP/IP-based networks, the most common being the Internet. HTTP is often referred to as the World Wide Web protocol because it manipulates interconnected information around the globe.

The Model 9302/9304 HTTP server manages multiple connections simultaneously. HTTP is a client-server protocol. The client host initiates a transfer by contacting the server host. The most common HTTP client is a web browser, such as Microsoft Internet Explorer or Netscape Navigator. The web browser, referred to as the web client, issues HTTP requests to access information from the Model 9302/9304.

SMTP: The Simple Mail Transport Protocol is used to send E-mail from the Model 9302/9304 to a selected address.

TIMEP: The Time Protocol allows a client to obtain the date and time from a host TIMEP server. If a time server is available on the Local Area Network, the Model 9302/9304 will periodically query it to update it's internal clock.

TCP/IP: The Transmission Control Protocol / Internet Protocol provides reliable, flow-controlled, end-to-end, communication between two machines. TCP operates even if datagrams are delayed, duplicated, lost, delivered out of order, or delivered with corrupted or truncated data. TCP/IP uses port numbers to identify the many application protocols that can run over it.

In the Model 9302/9304, a TCP/IP port is available for communication using an ASCII command language. This is how the instrument interfaces to data acquisition software, including LabView.

Ethernet IP Configuration

Each device on an Ethernet Local Area Network must have a unique IP Address. This is similar to IEEE-488 systems where each device required a unique 'GPIB' address. Further, the address assigned to the Model 9302/9304 must be within the range of the computers you want it to communicate with. The range is determined by the Subnet Mask.

The Model 9302/9304 is shipped with a default IP address of **192.168.0.4** and Subnet Mask of **255.255.255.0**.

You can configure the Model 9302/9304 to use any IP address from the front panel by going to the Network Configuration Menu.

Alternatively, You can configure your PC's Network connection with an IP address that is in the same range as the Model 9302/9304 IP address (**192.168.0.x**) and connect to the instrument using a **crossover** cable between your PC and the Model 9302/9304.

Once the IP is correctly set, you can go to the DOS-Prompt and ping 192.168.0.4. If you receive responses back, you can go to the Web browser and type in ***http://192.168.0.4*** and it will take you to the Model 9302/9304's Home Page.

From the Model 9302/9304's web page, you can completely configure the instrument to meet your network requirements.

Web site configuration

The Model 9302/9304 factory default settings are as follows:

IP address: 192.168.0.4
Subnet Mask: 255.255.255.0
Gateway: 192.168.0.1
TCP Data Socket: 5000

These settings are also entered into the Model 9302/9304 when the LAN Reset sequence is executed from the front panel.

The Model 9302/9304 does not support DHCP since dynamic addressing could possibly relocate the unit on the LAN with each power up.

LAN configuration is performed by the Network Configuration web page described in the “Network Configuration” section above. To display this page in your web browser, you must first connect to the Model 9302/9304.

When the above factory defaults are set, the Model 9302/9304 can be connected to a PC on the same LAN segment by using the LAN connector on the rear panel. If you are connecting to a LAN switch or hub, use a standard Category 5 patch cable with standard RJ-45 connectors. If you wish to connect directly to a PC, use a Category 5 Crossover type patch cable.

The PC may need to be configured to be on the same LAN segment as the Model 9302/9304. This is done by modifying the TCP/IP settings in the PC to have an IP of 192.168.0.xxx where <xxx> is in the range of 0 to 255 excluding 4 (The Model 9302/9304 address).

Once connected, you may change the network configuration of the Model 9302/9304 to have any desired values.

> ※ **NOTE:** The Model 9302/9304 network configuration parameters may be reset to the factory default values by executing the LAN Reset sequence from the front panel. This will restore the IP address to 192.168.0.4 as well as other network settings.

TCP Data Socket Configuration

In order to communicate with the Model 9302/9304 in the SCPI command language, you must configure a TCP data socket application in your PC using remote port 5000. This will allow you to communicate with the Model 9302/9304 in the same ASCII command language as the RS-232 port.

RS-232 Configuration

The user can select RS-232 Baud Rates between 300 and 38,400. The factory default is 9600.

The Baud Rate can be changed from the instrument's front panel by using the SYS menu.

Other RS-232 communications parameters are fixed in the instrument. They are set as follows:

Parity: None
Bits: 8
Stop Bits: 1
Mode: Half Duplex

The RS-232 interface uses a "New Line", or Line Feed character as a line termination. In the C programming language, this character is \n or hexadecimal 0xA.

When sending strings to the monitor, any combination of the following characters must be sent to terminate the line:

1. Carriage Return, Hex 0xD.
2. Line Feed, \n, Hex 0xA.
3. Null, 0.

The monitor will always return the carriage-return linefeed (\r\n) character sequence at the end of each line.

Introduction to Remote Programming

Instructions

Instructions (both commands and queries) normally appear as a string embedded in a statement of your host language, such as BASIC or C.

Instructions are composed of two main parts: The header, which specifies the command or query to be sent; and the parameters, which provide additional data needed to clarify the meaning of the instruction.

An instruction header is comprised of one or more keywords separated by colons (:). Queries are indicated by adding a question mark (?) to the end of the header. Many instructions can be used as either commands or queries, depending on whether or not you have included the question mark. The command and query forms of an instruction usually have different parameters. Many queries do not use any parameters.

The white space is used to separate the instruction header from the instruction parameters. If the instruction does not use any parameters, you do not need to include any white space. White space is defined as one or more spaces. ASCII defines a space to be character 32 (in decimal).

Instruction parameters are used to clarify the meaning of the command or query. Each instruction's syntax definition shows the parameters, as well as the values they accept.

Headers

There are three types of headers: Simple Command; Compound Command; and Common Command.

Simple command headers contain a single keyword. CONTROL and STOP are examples of single command headers. The syntax is:

<function><terminator>

When parameters (indicated by <data>) must be included with the simple command header (for example, INPUT CHA) the syntax is:

<function><white space><data><terminator>

Compound command headers are a combination of two or more keywords. The first keyword selects the subsystem, and the last keyword selects the function within that subsystem. Sometimes you may need to list more than one subsystem before being allowed to specify the function. The keywords within the compound header are separated by colons. For example:

SYSTEM:AMBIENT?

To execute a single function within a subsystem, use the following:

:<subsystem>:<function><white space><data><terminator>

Command headers control IEEE 488.2 defined functions within the instrument (such as clear status, etc.). Their syntax is:

*<command header><terminator>

No space or separator is allowed between the asterisk and the command header. *CLS is an example of a common command header.

To execute more than one function within the same subsystem a semi-colon (;) is used to separate the functions:

:<subsystem>:<function><white space><data>

<function><white space><data><terminator>

Command headers immediately followed by a question mark (?) are queries. After receiving a query, the instrument interrogates the requested function and places the response in its output queue. The output message remains in the queue until it is read or another command is issued.

Query commands are used to find out how the instrument is currently configured. They are also used to get results of measurements

> The output queue must be read before the next command is sent. For example, when you send the query, you must follow it with an input statement.

Truncation of Keywords

If a keyword contains more than four characters, it may be truncated to four or less characters to simplify programming.

The truncated form of a keyword is the first four characters of the word, except if the last character is a vowel. If so, the truncated form is the first three characters of the word.

SCPI Status Registers

The Instrument Status Register

The Instrument Status Register (ISR) is queried using the SYSTEM:ISR? command.

The ISR is commonly used to generate a service request (GPIB) when various status conditions occur. In this case, the ISR is masked with the Instrument Status Enable (ISE) register.

The ISR is defined as follows:

ISR

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Alarm	Rly1	Rly0				SFB	SFA

Where:

Bit7 – Alarm: Indicates that an alarm condition is asserted. Use the ALARM commands to query individual alarms.

Bit6 – Rly1: Indicates that Relay #1 has toggled. Use the RELAYS command to query individual relays.

Bit5 – Rly0: Indicates that Relay #0 has toggled.

Bit1 to Bit0 – SFx: Indicates that a sensor fault condition is asserted on an input channel. Use the INPUT commands to query the input channels.

The Instrument Status Enable Register

The Instrument Status Enable (ISE) Register is a mask register. It is logically “anded” with the contents of the ISR in order to set the Instrument Event (IE) bit in the Status Byte (STB) register. Bits in the ISE correspond to the bits in the ISR defined above.

The Standard Event Register

The Standard Event Register (ESR) is defined by the SCPI to identify various standard events and error conditions. It is queried using the Common Command *ESR? This register is often used to generate an interrupt packet, or service request when various I/O errors occur.

Bits in the ESR are defined as follows:

ESR

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
OPC		QE	DE	EE	CE		PWR

Where:

Bit7 – OPC: Indicates Operation Complete.

Bit5 – QE: Indicates a Query Error. This bit is set when a syntax error has occurred on a remote query. It is often used for debugging.

Bit4 – DE: Indicates a Device Error.

Bit3 – EE: Indicates an Execution Error. This bit is set when a valid command was received, but could not be executed. An example is attempting to edit a factory supplied calibration table.

Bit2 – CE: Indicates a Command Error. This bit is set when a syntax error was detected in a remote command.

Bit0 – PWR: Indicates power is on.

The Standard Event Enable Register

The Standard Event Enable Register (ESE) is defined by the SCPI as a mask register for the ESR defined above. It is set and queried using the Common Command *ESE.

Bits in this register map to the bits of the ESR. The logical AND of the ESR and ESE registers sets the Standard Event register in the Status Byte (STB).

The Status Byte

The Status Byte (STB) is defined by the SCPI and is used to collect individual status bits from the ESE and the ISR as well as to identify that the instrument has a message for the host in its output queue. It is queried using the Common Command *STB?. Bits are defined as follows:

STB

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
	RQS	SE	MAV	IE			

Where:

Bit6 – RQS: Request for Service.

Bit5 – SE: Standard Event. This bit is set as the logical ‘AND’ of the ESR and ESE registers.

Bit4 – MAV: Message Available

Bit3 – IE: Instrument Event. This bit is set as the logical ‘AND’ of the ISR and ISE registers.

The Status Byte Register

The Status Enable Register (SRE) is defined by the mask register for the STB. It is set and queried using the Common Commands *SRE.

The logical ‘AND’ of the SRE and STB registers is used to generate a service request on the GPIB interface.

Remote Commands

IEEE488 Common commands.

The Common Commands are defined by the IEEE-488.2 standard and are supported by the Model 9302/9304 on the all of the remote interface ports.

The common commands control some of the basic instrument functions, such as instrument identification and reset. They also provide an instrument status reporting mechanism.

***IDN?** Query unit Identification

Query unit identification string.

The *IDN? Query will cause the instrument to identify itself. The Model 9302/9304 will return the following string:

"Scientific Instruments 9304,<device S/N>,<fimware rev code>"

Where <device S/N> is the serial number of the unit and <firmware rev code> is the revision level of the firmware code.

Query Syntax: *IDN?
Query Response: <Instrument Identification String>

***OPC** Operation Complete

The *OPC command will cause the instrument to set the operation complete bit in the Standard Event (SEV) status register when all pending device operations have finished.

The *OPC? Query places an ASCII '1' in the output queue when all pending device operations have completed.

Command Syntax: *OPC

Query Syntax: *OPC?
Query Response: 1

SYSTEM commands

SYSTEM commands are a group of commands associated with the overall status and configuration of the Model 9302/9304 rather than a specific internal subsystem.

SYSTEM:DISTC: Display Filter Time Constant.

The SYSTEM:DISTC command is used to set or query the display filter time constant.

The display filter is applied to all reported or displayed temperature data. Available time constants are 0.5, 1, 2, 4, 8, 16, 32 or 64 Seconds.

Command Syntax: SYSTEM:DISTC <tc>
Where <tc> is the display filter time constant, in seconds, selected from the following list: 0.5, 1, 2, 4, 8, 16.

Query Syntax: SYSTEM:DISTC?
Query Response: <tc>

Command Example: SYSTEM:DISTC 8
This command will set the display time constant to 8 Seconds.

Query Example: SYSTEM:DISTC?
Example Response: 2
This indicates that the display filter has a 2 Second time constant.

Short Form: SYST:DIST

SYSTEM:FWREV: Instrument Firmware Revision Level

Queries the instrument's firmware revision level.

Query Syntax: SYSTEM:FWREV?

Query Example: SYSTEM:FWREV?
Example Response: 2.08
Indicating that the instrument's firmware is revision level 2.08.

Short Form: SYST:FWR

SYSTEM:HWREV: Instrument Hardware Revision Level

Queries the instrument's firmware revision level.

Query Syntax: SYSTEM:HWREV?

Query Example: SYSTEM:HWREV?
Example Response: B
Indicating that the instrument's firmware is revision level B.

Short Form: SYST:HWR

SYSTEM:DRES: Display Resolution.

Sets or queries the monitor's display resolution. Choices are:

FULL: The VFD will display temperature with the maximum possible resolution.

1, 2 or 3: The VFD display will display the specified number of digits to the right of the decimal point.

NOTE: This command only sets the number of digits displayed on the front panel VFD. It does NOT affect the internal accuracy of the instrument or the format of measurements reported on the remote interfaces.

The main use for this command is to eliminate the flicker in low order digits when the monitor is used in a noisy environment.

Command Syntax: SYSTEM:DRES <res>
Where <res> is the display resolution as follows: FULL, 1, 2, 3.

Command Example: SYSTEM:DRES 2
Causes the VFD display to show temperature with two digits to the right of the decimal point..

Query Syntax: SYSTEM:DRES?
Query Response: <res>
Where <res> is the display resolution

Query Example: SYSTEM:DRES?
Example Response: FULL

Short Form: SYST:DRES

SYSTEM:DATE: System Date

Set or query the instrument's date. String format is dd/mm/yyyy.

Command Syntax: SYSTEM:DATE <date>
Where <date> is the date string in double quotes.

Command Example: SYSTEM:DATE "15/8/2003"
Sets the Model 9302/9304's date to August 15, 2003.

Query Syntax: SYSTEM:DATE?

Query Example: SYSTEM:DATE?
Example Response: 12/ 9/2004 for September 12, 2004.

Short Form: SYS:DAT

SYSTEM:TIME: System Time

Set or query the instrument's time. String format is hh:mm:ss.

Command Syntax: SYSTEM:TIME <time>
Where <time> is the date string in double quotes.

Command Example: SYSTEM:TIME "22:23:00"
Sets the Model 9302/9304's time to 22:23:00 or 10:23PM.

Query Syntax: SYSTEM:TIME?

Query Example: SYSTEM:TIME?
Example Response: 11:22:04.

Short Form: SYS:TIM

SYSTEM:RESEED: Re-seed the display filters

Re-seeds the input channel's averaging filter, allowing it to settle significantly faster.

Command Syntax: SYSTEM:RESEED

Command Example: SYSTEM:RESEED

Short Form: SYS:RES

INPUT commands

The INPUT group of commands is associated with the configuration and status of the four input channels.

INPUT may also be a stand-alone query.

Parameter references to the input channels may be:

- Numeric ranging in value from zero to two.
- Channel ID tags including ChA, ChB, ChC or ChD.
- Alphabetic including A, B, C or D.

INPUT: Input Channel Temperature Query.

The INPUT query reports the current temperature reading on any of the input channels.

Temperature is filtered by the display time constant filter and reported in display units.

Query Syntax: INPUT ? <channel>
Where <channel> is the input channel parameter.
Query Response: <temp>
Where <temp> is the temperature of the specified input channel in display units (K, F, C or S).
Floating Point string.

Query Example: INPUT? B
Example Response: 123.4567

Alternate Form: INPUT <channel>:TEMP?

Short Form: INP

INPUT:TEMPER: Input Temperature.

The INPUT:TEMPER query is identical to the input query described above. It reports the current temperature reading on any of the input channels.

Temperature is filtered by the display time constant filter and reported in display units.

Query Syntax: INPUT <channel>:TEMPER?
Where <channel> is the input channel parameter.
Query Response: <temp>
Where <temp> is the temperature of the specified input channel in display units (K, F, C or S).
Floating Point string.

Query Example: INP B:TEMP?
Example Response: 12.45933

Short Form: INP <channel>:TEMP?

INPUT:UNITS Input channel units

Sets or reports the display units of temperature used by the specified input channel.

Command Syntax: INPUT <channel>:UNITS <units>
Where <channel> is the input channel parameter and <units> is the display units indicator.

<units> may be K for Kelvin, C for Celsius, F for Fahrenheit or S for primitive sensor units. In the case of sensor units, the instrument will determine if the actual units are Volts or Ohms based on the actual sensor type selected for the input channel.

Query Syntax: INPUT <channel>:UNITS?
Where <channel> is the input channel indicator.
Query Response: <units>
Where <units> is the display units indicator which will be K, C, F, V for Volts or O for Ohms.

Command Example: INPUT B:UNITS F

Query Example: INP A:UNIT?
Example Response: K

Query Example: INP A:TEMP?;UNIT?
Example Response: 27.9906K

Short Form: INP:UNIT

INPUT:ISENIX Installed Sensor index

Sets or queries the sensor index number assigned to an input channel for factory installed sensors.

Sensor index zero indicates that there is no sensor connected to the selected input channel. This will disable all readings on the channel.

Refer to Appendix A for a description of sensors, indices etc.

> **Note:** The use of the ISENIX command to assign a factory-installed sensor and the USENIX command to assign a user sensor are preferred to the use of the obsolete SENIX command.

The SENTYPE command may be used to query the name of a factory-installed sensor at a specific index.

Command Syntax: INPUT <channel>:ISENIX <ix>
Where <channel> is the input channel parameter and <ix> is the desired sensor index.

Query Syntax: INPUT <channel>:ISENIX?
Where <channel> is the input channel indicator.
Query Response: <ix>
Where <ix> is the sensor index for the selected input channel. If the index is invalid, a value of –1 will be returned.

Command Example: INPUT B:SENIX 0
This command sets the sensor index for input channel B to zero (disabled).

Query Example: INP A:SENIX?
Example Response: 02

This indicates that sensor 02 is assigned to input channel A. The name of factory installed sensor 02 may be accessed using the SENTYPE commands.

Short Form: INP:SEN

INPUT:USENIX User Sensor index

Sets or queries the sensor index number assigned to an input channel for user installed sensors.

Refer to Appendix A for a description of sensors, indices etc.

An index number of 0 through 3 indicates user sensor curves 0 through 3.

> **Note:** The use of the ISENIX command to assign a factory installed sensor and the USENIX command to assign a user sensor are preferred to the use of the obsolete SENIX command.

The CALD command may be used to query information about the user installed sensor curves.

Command Syntax: INPUT <channel>:USENIX <ix>
Where <channel> is the input channel parameter and <ix> is the desired sensor index.

Query Syntax: INPUT <channel>:USENIX?
Where <channel> is the input channel indicator.
Query Response: <ix>
Where <ix> is the sensor index for the selected input channel. If the index is outside of the range 0 through 3, a value of –1 will be returned.

Command Example: INPUT B:USENIX 0
This command sets the sensor index for input channel B to zero (disabled).

Query Example: INP A:USENIX?
Example Response: 2

This indicates that sensor 02 is assigned to input channel A.

Short Form: INP:SEN

INPUT:SENIX Sensor index (obsolete)
Sets or queries the sensor index number assigned to an input channel. This command is used to assign the sensor type to a channel. Sensor types and configurations are accessed using the SENTYPE commands.

Sensor index zero indicates that there is no sensor connected to the selected input channel. This will disable all readings on the channel.

Refer to Appendix A for a description of sensors, indices etc.

> **Note:** To ensure portability of software written for the Model 32, you should use the ISENIX command to assign a factory installed sensor or USENIX to assign a user sensor. This way, the index will always correspond to the correct sensor regardless of the Model 32 firmware revision.

Command Syntax: INPUT <channel>:SENIX <ix>
Where <channel> is the input channel parameter and <ix> is the desired sensor index.

Query Syntax: INPUT <channel>:SENIX?
Where <channel> is the input channel indicator.
Query Response: <ix>
Where <ix> is the sensor index for the selected input channel.

Command Example: INPUT B:SENIX 0
This command sets the sensor index for input channel B to zero (disabled).

Query Example: INP A:SENIX?
Example Response: 02

This indicates that sensor 02 is assigned to input channel A. The name and configuration of sensor 02 may be accessed using the SENTYPE commands.

Short Form: INP:SEN

INPUT:ALARM?: Input Channel Alarm Status.

Queries the alarm status of the specified input channel. Status is a two character string where:

--	indicates that no alarms are asserted
SF	indicates a Sensor Fault condition.
HI	indicates a high temperature alarm
LO	indicates a low temperature alarm.

There is a 0.25K hysteresis in the assertion of a high or low temperature alarm condition.

The user selectable display time constant filter is applied to input channel temperature data before alarm conditions are tested.

Query Syntax: INPUT <channel>: ALARM?
Query Response: <alarm>
Where <channel> is the input channel indicator and <alarm> is the alarm status indicators for that channel.

Query Example: INP A:ALARM?
Example Response: --
Which indicates that no alarm is asserted for input channel A.

Short Form: INP <channel>:ALAR?

INPUT:ALARM:HIGHEST: Alarm High Set Point.

Sets or queries the temperature setting of the high temperature alarm for the specified input channel. When this temperature is exceeded, an enabled high temperature alarm condition will be asserted.

Temperature is assumed to be in the display units of the selected input channel.

There is a 0.25K hysteresis in the assertion of a high or low temperature alarm condition.

Command Syntax: INPUT <channel>:ALARM:HIGHEST <temp>
Where <channel> is the input channel indicator and <temp> is the alarm set point temperature. .
Temperature is a floating point string that may be up to 20 characters.

Query Syntax: INPUT <channel>: ALARM:HIGHEST?
Query Response: <temp>
Where <channel> is the input channel indicator and <temp> is the temperature setting of the high temperature alarm for <channel>. Temperature is reported to the full precision of 32 bit floating point.

Command Example: INP A:ALARM:HIGH 200.5
Sets the high temperature alarm set point for input channel A to 200.5.

Query Example: INP A:ALARM:HIGHEST?
Example Response: 125.4321
If the display units setting for input channel A are Kelvin, this response is also in units of Kelvin.

Short Form: INP <channel>:ALAR:HIGH

INPUT:ALARM:LOWEST: Alarm Low Set Point.

Sets or queries the temperature setting of the low temperature alarm for the specified input channel. When the input channel temperature is below this, an enabled low temperature alarm condition will be asserted.

Temperature is assumed to be in the display units of the selected input channel.

There is a 0.25K hysteresis in the assertion of a high or low temperature alarm condition.

Command Syntax: INPUT <channel>:ALARM:LOWEST <temp>
Where <channel> is the input channel indicator and <temp> is the alarm set point temperature. Temperature is a floating point string that may be up to 20 characters.

Query Syntax: INPUT <channel>: ALARM:LOWEST?
Query Response: <temp>
Where <channel> is the input channel indicator and <temp> is the temperature setting of the low temperature alarm for <channel>. Temperature is reported to the full precision of 32 bit floating point.

Command Example: INP A:ALARM:LOW 100.5
Sets the low temperature alarm set point for input channel A to 100.5.

Query Example: INP B:ALARM:LOW?
Example Response: 25.43210
If the display units setting for input channel B are Celsius, this response is also in units of Celsius.

Short Form: INP <channel>:ALAR:LOW

INPUT:ALARM:HIENA: Alarm High Enable.

Sets or queries the high temperature alarm enable for the specified input channel.

An alarm must be enabled before it can be asserted.

Command Syntax: INPUT <channel>:ALARM:HIENA <status>
Where <channel> is the input channel indicator and <status> is the status of the high temperature alarm enable. <status> may be either YES or NO.

Query Syntax: INPUT <channel>: ALARM:HIENA?
Query Response: <status>
Where <channel> is the input channel indicator and <status> is the setting of the high temperature alarm enable for <channel>. <status> will be either YES or NO.

Command Example: INPUT A:ALARM:HIENA NO
Disables the high temperature alarm for input channel A.

Query Example: INP B:ALARM:HIEN?
Example Response: YES

Query / Command Example: INP B:ALARM:HIGH?;HIEN NO
Example Response: 154.2323
The high temperature alarm set point for channel B is reported. Then the high temperature alarm for channel B is disabled.

Short Form: INP <channel>:ALAR:HIEN

INPUT:ALARM:LOENA: Alarm Low Enable.

Sets or queries the low temperature alarm enable for the specified input channel.

An alarm must be enabled before it can be asserted.

Command Syntax: INPUT <channel>:ALARM:LOENA <status>
Where <channel> is the input channel indicator and <status> is the status of the low temperature alarm enable. <status> may be either YES or NO.

Query Syntax: INPUT <channel>: ALARM:LOENA?
Where <channel> is the input channel indicator.

Query Response: <status>
Where <status> is the setting of the low temperature alarm enable for <channel>. <status> will be either YES or NO.

Command Example: INPUT A:ALARM:LOENA YES
Enables the low temperature alarm for input channel A.

Query Example: INP B:ALARM:LOEN?
Example Response: NO

Query Example: INP B:ALARM:HIENA?;LOENA?
Example Response: YES;NO
The high temperature alarm enable for input channel B is reported, followed by the low temperature alarm enable.

Short Form: INP <channel>:ALAR:LOEN

INPUT:VBIAS Input channel sensor bias voltage

Sets or queries the constant-voltage mode voltage used on the specified input channel. This value only applies to sensors that use constant-voltage excitation. They are indicated by a sensor type of ACR.

If this query is used with a sensor type other than ACR, it will always return N/A for not applicable.

Command Syntax: INPUT <channel>:VBIAS <volts>
Where <channel> is the input channel parameter and <volts> is the bias voltage. Choices are:

1.0V	–	1.0 Volt
10mV	–	10milliVolt.
3.3mV	–	3.33milliVolt.
1.0mV	–	1.0milliVolt.

Query Syntax: INPUT <channel>:VBIAS?
Where <channel> is the input channel indicator.
Query Response: <volts>

Command Example: INPUT B:VBIAS 3.3mV

Query Example: INP A:VBias?
Example Response: 1.0mV. Note: if the sensor on channel A is not a type ACR, the response will always be N/A.

Short Form: INP:VBIAS

Relay Commands

The relay subsystem includes the two auxiliary relays in the Model 9302/9304. Using the RELAYS commands, these relays may be independently configured to assert or clear based on the status of any of the four sensor input channels.

Relay outputs are dry-contact and are available on the rear panel of the instrument.

The user selectable display time constant filter is applied to input channel temperature data before relay conditions are tested.

RELAYS? Relay Status Query.

The two auxiliary relays available in the Model 9302/9304 are addressed as 0 and 1. The RELAYS command can be used to query the status of each relay where:

--	Relay is clear.
SF	Relay is asserted by a Sensor Fault condition.
HI	Relay is asserted by a high temperature condition.
LO	Relay is asserted by a low temperature condition.

There is a 0.25K hysteresis in the assertion of a high or low temperature conditions.

Query Syntax: RELAYS? <num>
Query Response: <status>
Where <num> is the relay number and is 0 or 1. <status> is the assertion status of relay <num> and is selected from the above list.

Query Example: RELAY? 1
Example Response: HI
This response indicating that relay #1 is asserted by a high temperature condition.

Query Example: RELAY? 0
Example Response: --
Indicating that relay #0 is not asserted.

Short Form: REL?
The short form is truncated to three characters since the fourth character is a vowel.

RELAYS: SOURCE: Relay Input Source.
Sets or queries the source input channel for a specified relay.

Command Syntax: RELAYS <num>:SOURCE <chan>
Where <num> is the relay number and is 0 or 1. <chan> is source input channel and may be any of the Model 9304's four sensor inputs or Model 9302's two.

Query Syntax: RELAYS <num>:SOURCE?
Where <num> is the relay number.
Query Response: <chan>
Where <chan> is the source input channel for relay <num> and will be ChA, ChB, ChC or ChD.

Command Example: RELAY 0:SOUR D
Causes relay 0 to be asserted or cleared based on the condition of input channel D.

Query Example: RELAY 1:SOUR?
Example Response: CHC

Short Form: REL:SOUR

RELAYS: HIGHEST: Relay High Set Point.
Sets or queries the temperature setting of the high temperature set point for the specified relay. When this temperature is exceeded on the source input channel, a high temperature condition will cause the specified relay to be asserted.

Temperature is assumed to be in the display units of the source input channel.

There is a 0.25K hysteresis in the assertion of a high or low temperature condition.

Command Syntax: RELAYS <num>:HIGHEST <temp>
Where <num> is the relay number and is 0 or 1. <temp> is the set point temperature. .
Temperature is a floating point string that may be up to 20 characters.

Query Syntax: RELAYS <num>:HIGHEST?
Where <num> is the relay number.

Query Response: <temp>
Where <temp> is the value of the set point for relay <num>. Temperature is reported to the full precision of 32 bit floating point.

Command Example: RELAY 0:HIGHEST 25.947
Sets the high temperature set point for relay 0 to 25.947

Query Example: RELAY 1:HIGHEST?
Example Response: 125.4321
If the display units setting for the source input channel are Kelvin, this response is also in units of Kelvin.

Short Form: REL:HIGH

RELAYS:LOWEST: Relay Low Set Point.
Sets or queries the temperature setting of the low temperature set point for a specified relay. When the source input channel temperature is below this value, an enabled low temperature condition will be asserted.

Temperature is assumed to be in the display units of the selected source input channel.

There is a 0.25K hysteresis in the assertion of a high or low temperature alarm condition.

Command Syntax: RELAYS <num>:LOWEST <temp>
Where <num> is the relay number and is 0 or 1. <temp> is the set point temperature. Temperature is a floating point string that may be up to 20 characters.

Query Syntax: RELAYS <num>:LOWEST?
Where <num> is the relay number.
Query Response: <temp>
Where <temp> is the low temperature set point. Temperature is reported to the full precision of 32 bit floating point.

Command Example: RELAY 1:LOW 100.5
Sets the low temperature set point for relay 1 to 100.5.

Query Example: RELAY 0:LOW?
Example Response: 25.43210

Short Form: REL:LOW

RELAYS: HIENA: Relay High Enable.
Sets or queries the high temperature enable for the specified relay.

A relay must be enabled before it can be asserted.

Command Syntax: RELAYS <num>:HIENA <status>
Where <num> is the number of the relay and is 0 or 1. <status> is the status of the high temperature enable. <status> may be either YES or NO.

Query Syntax: RELAYS <num>:HIENA?
Query Response: <status>
Where <num> is the relay number and <status> is the setting of the high temperature enable for relay <num>. <status> will be either YES or NO.

Command Example: RELAY 1:HIENA NO
Disables the high temperature alarm assertion of relay number 1.

Query Example: REL 0:HIEN?
Example Response: YES

Query / Command Example: RELAY 1:HIGH?;HIEN NO
Example Response: 154.2323
The high temperature alarm set point for relay 1 is reported then the high temperature enable for relay 1 is disabled.

Short Form: REL:HIEN

RELAYS:LOENA: Relay Low Enable.
Sets or queries the low temperature enable for the specified relay.

A relay must be enabled before it can be asserted.

Command Syntax: RELAYS <num>:LOENA <status>
Where <num> is the relay number and is 0 or 1. <status> is the status of the low temperature enable. <status> may be either YES or NO.

Query Syntax: RELAYS <num>:LOENA?
Query Response: <status>
Where <num> is the relay number and <status> is the setting of the low temperature alarm enable for <channel>. <status> will be either YES or NO.

Command Example: RELAY 1:LOENA YES
Enables low temperature assertion for relay #1.

Query Example: RELAY 0:LOEN?
Example Response: NO

Query Example: REL 0:HIENA?;LOENA?
Example Response: YES;NO
Indicates that relay 0 will assert on a high temperature condition but not on a low temperature condition.

Short Form: REL:LOEN

CALCUR commands

The CALCUR commands are used to transfer sensor calibration curves between the monitor and the host controller.

Curves are referenced by an index number. In the Model 9302/9304 there are six user curves numbered 1 through 6.

The CALCUR data block consists of a header, multiple curve entries and a terminator character.

The header consists of four lines as follows:

Sensor Name:	Sensor name string, 15 characters max
Sensor Type:	Enumeration, See Sensor Types table
Multiplier:	Signed numeric
Units:	Units of calibration curve: OHMS, VOLTS or LOGOHM

Each entry of a curve contains a sensor reading and the corresponding temperature. Sensor readings are in units specified by the units of the curve using the CALDATA:UNITS command. These units may be OHMS, VOLTS or LOGOHM. Temperature is always in Kelvin.

The format of an entry is:

<sensor reading> <Temperature>

Where <sensor reading> is a floating-point sensor reading and <Temperature> is a floating-point temperature in Kelvin.

Numbers are separated by one or more white spaces.

NOTE: Using the Ethernet or RS-232 interface, each line must be terminated by a New Line, a Carriage Return, a Line Feed or a Null character.

Floating point numbers may be entered with many significant digits. They will be converted to 32 bit floating point. This supports about six significant digits.

The last entry of a table is indicated by a semicolon (;) character with no values in the numeric fields.

NOTE: All curves must have a minimum of two entries and a maximum of 200 entries.

Entries may be sent to the monitor in any order. The unit will sort the curve in ascending order of sensor reading before it is copied to Flash RAM.

Entries containing invalid numeric fields will be deleted before they are stored.

The following is an example of a calibration curve transmitted to the monitor via the LAN interface:

```
CALCUR 1\n
Good Diode\n
Diode\n
–1.0\n
volts\n
0.34295   300.1205\n
0.32042   273.1512\n
0.35832   315.0000\n
1.20000   3.150231\n
1.05150   8.162345\n
0.53234   460.1436\n
; \n
```

The monitor would sort the above table in ascending order of volts, then write it to FLASH memory as user curve #1. The curve name will be "Good Diode" and the native units are volts.

When a complete curve is received, it is conditioned, sorted and copied to FLASH memory. This process can take as long as 250 milliseconds with a long table.

NOTE: When using the RS-232 interface, a time delay should of about 500mS should be inserted after sending the last line of a calibration table. This will allow the flash memory update to complete. Other remote interfaces do not require a delay.

> ※ **NOTE:** Factory installed calibration curves may not be changed or deleted with these commands.

CALCUR: Calibration Curve Set or Query.

Sets or queries sensor calibration curve data.

Command Syntax:

CALCUR <index>
<sensor name>
<sensor type>
<multiplier>
<curve units>
<sensor reading 1> <Temperature 1>
<sensor reading 2> <Temperature 2>
•
•
<sensor reading N> <Temperature N>
;

A new line (\n) character must be appended to each line.

The maximum number of entries in a curve is 200 and the minimum is 2.

<index> is a numeric index to the user calibration curve list. Values are 1 through 6 in the Model 9302/9304.

<curve name> is a name to be assigned to the calibration curve. It is a minimum of 4 and a maximum of 15 ASCII characters.

<sensor type> is from the following list: "SiDiode", "R250K10UA", "R62K10UA", "R31K10UA". "R15K10UA", "R8K10UA", "R625R1MA", "R312R1MA", "R156R1MA" or “Snone"

Sensor Types are described in the section on Supported Sensors above.

<multiplier> is the temperature coefficient and curve multiplier. If this field cannot be identified, a value of –1.0 is assumed. This field is described in the section Sensor Setup Menu above.

<curve units> is the units of the curve. Choices are OHMS, VOLTS or LOGOHM.

The last entry in a calibration curve must be a single semicolon.

Query Syntax: CALCUR? <index>
Query Response: <calibration curve>

Short Form: CALC

CALDATA and SENTYPE Commands

The CALDATA commands are used to add, delete or edit user-installed sensors.

SENTYPE commands are used to query the name of a factory-installed sensor.

User-installed sensors are indexed from zero to 5. Factory installed sensors are indexed from zero to 60. For additional information, refer to Appendix A.

SENT:NAME: Name for a factory-installed sensor.

Queries the name of a factory-installed sensor.

Query Syntax: SENT <index>:NAME? Or SENT? <index>
Query Response: <name>
Where <index> is the index of the factory-installed sensor and <name> is the name string for the indexed sensor.

Query Example: SENT? 1
Example Response: “Scientific Instruments Si410”.

Short Form: SENT?

CALDATA:NAME: Name for a user-installed sensor.

Sets or queries the name of a user-installed sensor. .

Command Syntax: CALDATA <index>:NAME <val>
Where <index> is the index of the user-installed sensor and <val> the sensor’s name string. The name string must be surrounded with double-quotation (“) marks.

Query Syntax: CALDATA <index>:NAME?
Query Response: <name>
Where <index> is the index of the user-installed sensor and <name> is the name string for the indexed sensor.

Query Short Form: CALD? <index>
Where <index> is the index of the user-installed sensor and <val> the sensor’s name string.

Query Example: CALDATA 3:NAME?
Example Response: “User Curve 2”.

Short Form: CALD?

CALDATA:TYPE: Sensor Type.

Sets or queries the sensor type at a Sensor Table index.

Supported sensor types are described above in the "Supported Sensors" section.

Command Syntax: CALDATA <index>:TYPE <stype>
Where <index> is the index to the user-installed sensor and <stype> the sensor type selected from the above list.

Query Syntax: CALDATA <index>:TYPE?
Query Response: <stype>
Where <index> is the index and <stype> is the sensor type.

Command Example: SENT 3:TYPE DIODE
This command assigns the Silicon Diode sensor type to the user-installed sensor at index 3.

Query Example: CALDATA 1:TYPE?
Example Response: Diode
This response indicates that the sensor at index 1 is a Diode.

Short Form: CALD:TYP

CALDATA:MULTIPLY: Calibration Curve Multiplier.

Sets or queries the Multiplier field for a user-installed sensor. .

The multiplier field is a floating-point numeric entry and is used to specify the sensor's temperature coefficient and to scale the calibration curve. Negative multipliers imply that the sensor has a negative temperature coefficient. The absolute value of the multiplier scales the calibration curve. For example, the curve for a Platinum sensor that has 100Ω of resistance at 0°C may be used with a 1000Ω sensor by specifying a multiplier of 10.0.

Default is 1.0 for sensors with a positive temperature coefficient and –1.0 for a negative coefficient.

Command Syntax: CALDATA <index>:MULTIPLY <val>
Where <index> is the index to user installed sensor (0 through 5) and <val> the multiplier. <index> is an integer and <val> is floating point with a range of ±100.0.

Command Example: CALD 1:MULT –10.1
This command sets the calibration table multiplier for user-installed sensor 1 to –10.1 and identifies it as having a negative temperature coefficient.

Query Syntax: CALDATA <index>:MULTIPLY?
Query Response: <val>
Where <index> is the index and <val> is the sensor type multiplier.

Query Example: CALD 2:MULT?
Example Response: 1.000000
This response indicates that the sensor at index 2 has a positive temperature coefficient and a calibration curve multiplier of 1.0.

Short Form: CALD:MULT

Network Commands

These commands are used to configure the Ethernet interface. Once the IP address has been configured, it is expected that other network configuration will be performed using a web browser.

NETWORK: IPADDRESS Network IP address

Command Syntax: NETWORK:IPADDRESS <IP>
Where <IP> is the IP address string enclosed in double quotes.

Query Syntax: NETWORK:IPADDRESS?
Query Response: <IP>
Where <IP> is the Model 9302/9304's IP address.

Command Example: NETWORK:IPADDRESS "192.168.0.4"

Query Example: NETWORK:IPADDRESS?
Example Response: 192.168.0.100

Short Form: NETW:IPAD

NETWORK: MACADDRESS MAC address

Query Syntax: NETWORK:MACADDRESS?
Query Response: <MAC>
Where <MAC> is the Model 9302/9304's MAC address.

Query Example: NETWORK:MACADDRESS?
Example Response: 0f:12:34:56:a2:0b

Short Form: NETW:MAC

Remote Command Summary

Command	Function
IEEE Common Commands	
*ESE, *ESE?	The *ESE command sets and queries the Standard Event Status Enable (ESE) Register bits.
*ESR?	Returns the Standard Event (SEV) register.
*IDN?	Returns Instrument Identification String.
*OPC?	Set the operation complete bit in the Standard Event (SEV) status register when all pending device operations have finished.
*RST	Reset the monitor.
SYSTEM commands	
SYSTEM:DATE SYSTEM:DATE?	Set or query the instrument's real-time-clock date value.
SYSTEM:TIME SYSTEM:TIME?	Set or query the instrument's real-time-clock time value.
SYSTEM:DRES SYSTEM:DRES?	Sets or queries the monitor's display resolution. Choices are: Full, 1, 2 or 3.
SYSTEM:HWREV?	Queries the instrument's hardware revision level.
SYSTEM:FWREV?	Queries the instrument's firmware revision level.
SYSTEM:RESEED	Reseeds the display filter for all of the input channels, resulting in faster settling.
SYSTEM:DISTC SYSTEM:DISTC?	Set or query the display filter time constant. Available time constants are 0.5, 1, 2, 4, 8 or 16 Seconds.

Command	Function
Input Channel Commands	
INPUT? INPUT:TEMPER?	Query the current temperature reading on any of the input channels.
INPUT:UNITS INPUT:UNITS	Sets or reports the display units of temperature used by the specified input channel.
INPUT:SENIX INPUT:SENIX	Sets or queries the sensor index number assigned to an input channel.
INPUT:VBIAS INPUT:VBIAS?	Set or query the sensor voltage excitation used in the constant-voltage mode. Applies to constant-voltage mode sensors only.
INPUT:ALARM?	Queries the alarm status of the specified input channel.
INPUT:ALARM:HIGHEST INPUT:ALARM:HIGHEST?	Sets or queries the temperature setting of the high temperature alarm for the specified input channel.
INPUT:ALARM:LOWEST INPUT:ALARM:LOWEST?	Sets or queries the temperature setting of the low temperature alarm for the specified input channel.
INPUT:ALARM:HIENA INPUT:ALARM:HIENA?	Sets or queries the high temperature alarm enable for the specified input channel.
INPUT:ALARM:LOENA INPUT:ALARM:LOENA?	Sets or queries the low temperature alarm enable for the specified input channel.

Command	Function
Sensor Calibration Curve Commands	
CALCUR CALCUR?	Sets or queries sensor calibration curve data.

Command	Function
Relay Commands	
RELAYS?	Relay Status Query.
RELAYS: SOURCE RELAYS: SOURCE?	Sets or queries the source input channel for a specified relay.
RELAYS: HIGHEST RELAYS: HIGHEST?	Sets or queries the temperature setting of the high temperature set point for the specified relay.
RELAYS:LOWEST RELAYS:LOWEST?	Sets or queries the temperature setting of the low temperature set point for a specified relay.
RELAYS: HIENA RELAYS: HIENA?	Sets or queries the high temperature enable for the specified relay.
RELAYS:LOENA RELAYS:LOENA	Sets or queries the low temperature enable for the specified relay.
Sensor Setup Commands	
CALDATA? CALDATA:NAME CALDATA:NAME?	Sets or queries the name string for a user-installed sensor.
CALDATA:TYPE CALDATA:TYPE?	Sets or queries the sensor type for a user-installed sensor.
CALDATA:MULTIPLY CALDATA:MULTIPLY?	Sets or queries the Multiplier for a user-installed sensor.
SENTYPE? SENTYPE:NAME SENTYPE:NAME?	Queries the name string for a factory-installed sensor. Please refer to Appendix A.

Table 24: Remote Command Summary

Appendix A: Installed Sensor Curves

Factory Installed Curves

The following is a list of factory-installed sensors and the corresponding sensor index (ISENIX).

ISENIX	Name	Description
0	None	No Sensor. Used to turn the selected input channel off.
1	Cryocon S700	Cryo-con S700 series Silicon Diode. Range: 1.4 to 500K. 10μA constant current excitation.
2	LS DT-670	Lakeshore DT-670 series Silicon Diode, Curve 11. Range: 1.4 to 500K. 10μA constant current excitation.
3	LS DT-470	Lakeshore DT-470 series Silicon Diode, Curve 10. Range: 1.4 to 500K. 10μA constant current excitation.
5	SI 410 Diode	Scientific Instruments, Inc. 410 Diode Curve. Range: 1.5 to 450K. 10μA excitation.
20	Pt100 385	DIN43760 standard 100Ω Platinum RTD. Range: 23 to 873K, 1mA excitation.
21	Pt1K 385	1000Ω at 0°C Platinum RTD using DIN43760 standard calibration curve. Range: 23 to 1023K, 100μA excitation.
22	Pt10K 385	10KΩ at 0°C Platinum RTD. Temperature coefficient 0.00385, Range: 23 to 873K, 10μA excitation.
23	RhFe 27, 1mA	Rhodium-Iron. 27Ω at 0°C. 1mA DC excitation. 1.5 to 873K
31	RO-105 AC	SI RO-105 Ruthenium Oxide sensor. AC excitation. Use only the 1.0V constant voltage excitation. 2 to 273K
32	RO-105 DC 10uA	SI RO-105 with DC excitation. This is the recommended configuration for this high resistance sensor. 2 to 273K
33	RO-600 AC	SI RO-600 Ruthenium Oxide sensor. Constant voltage AC excitation.

The isenix remote command is used to set factory installed sensors. For example, the command:

INPUT B ISENIX 33 would set input B to use the RO-600 sensor.

INPUT A:ISENIX 1 would set input A to use the S700 Diode.

INPUT A:ISENIX 0 would turn input A off by setting the sensor to ‘none’.

User Installed Sensor Curves

The user may install up to four custom sensors. This table shows the sensor index and default name of the user curves:

usenix index	User Number	Default Name
0	**0**	User Sensor 0
1	**1**	User Sensor 1
2	**2**	User Sensor 2
3	**3**	User Sensor 3

When using the CALCUR commands, only user curves are addressed, therefore, the user index (usenix) shown above is used.

The USENIX, remote commands address user installed curves. For example:

CALCUR 2 would address user curve #2.

INPUT A:USENIX 1 would set input A to use User Sensor 1.

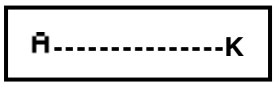
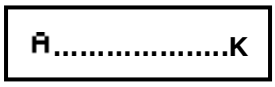
Sensor Curves on CD

The following sensors are available on the CD supplied:

File	Description
Cryocon S700	Cryo-con S700 series Silicon Diode. Range: 1.4 to 500K. 10μA constant current excitation.
CryocalD3.crv	Cryocal D3 Silicon Diode. Range: 1.5 to 300K
SI410.crv	Scientific Instruments, Inc. SI-410 Silicon Diode. Range: 1.5 to 450K
Curve10.crv	Lakeshore Curve 10 Silicon Diode curve for DT-470 series diodes. Range: 1.4 to 495K.
Curve11.crv	Lakeshore Curve 10 Silicon Diode curve for DT-670 series diodes. Range: 1.4 to 500K.
PT100385.crv	Cryocon CP-100, DIN43760 or IEC751 standard Platinum RTD, 100Ω at 0°C. Range: 23 to 1020K
PT1K385.crv	DIN43760 or IEC751 standard Platinum RTD, 1000Ω at 0°C. Range: 23 to 1020K
PT1003902.crv	Platinum RTD, 100Ω at 0°C Temperature coefficient 0.003902 Ω/C. Range: 73K to 833K.
PT1K375.crv	Platinum RTD, 1000Ω at 0°C Temperature coefficient 0.00375 Ω/C. Range: 73K to 833K.
aufe07cr.crv	Chromel-AuFe 7% Thermocouple. Range: 3 to 610K
TCTypeE.crv	Thermocouple, Type E. Range: 3.2 to 1273K
TCTypeK.crv	Thermocouple, Type K. Range: 3.2 to 1643K
TCTypeT.crv	Thermocouple, Type T. Range: 3.2 to 673K
CX1030E1.crv	Cernox™ CX1030 example curve. Range: 4 to 325K

Appendix B: Troubleshooting Guide

Error Displays

Display	Condition
 Or, an erratic display of temperature.	Input channel voltage measurement is out of range. Ensure that the sensor is connected and properly wired. Ensure that the polarity of the sensor connections is correct. Refer to the Sensor Connections section. Many sensors can be checked with a standard Ohmmeter. For resistor sensors, ensure that the resistance is correct by measuring across both the Sense and Excitation contacts. For a diode sensor, measure the forward and reverse resistance to ensure a diode-type function.
	Input channel is within range, but measurement is outside the limits of the selected sensor's calibration curve. Check sensor connections as described above. Ensure that the proper sensor has been selected. Refer to the Input Channel Setup Menus section. Change the sensor units to Volts or Ohms and ensure that the resulting measurement is within the selected calibration curve. Refer to the section on Sensor Setup to display the calibration curve.

Temperature Measurement Errors

Symptom	Condition
Noise on temperature measurements.	Possible causes: Excessive noise pickup, especially AC power line noise. Check your wiring and shielding. Sensors must be floating, so check that there is no continuity between the sensor connection and ground. Check for shielding problems by temporarily removing the input connector's backshell. If the noise changes significantly, current is being carried by the shields and is being coupled into the monitor. Use a longer display filter time constant to reduce displayed noise.

Symptom	Condition
DC offset in temperature measurements.	Possible causes: The wrong sensor type or sensor calibration curve is being used. Refer to the Input Channel Setup Menu section. A four-wire measurement is not being used. Some cryostats use a to a two-wire measurement internally. This can cause offset errors due to lead resistance.
No temperature reading.	Review the Error Displays section above.

Remote I/O problems

Symptom	Condition
Can't talk to RS-232 interface.	Possible causes: Ensure that the baud rate of the monitor matches that of the host computer. Ensure that the host computer settings are 8-bits, No parity, one stop bit. The RS-232 port does not have an effective hardware handshake method. Therefore, terminator characters must be used on all strings sent to the monitor. Review the RS-232 Configuration section. Ensure that you are using a Null-Modem type cable. There are many variations of RS-232 cables and only the Null-Modem cable will work with Model 9302/9304 monitors. This cable is detailed in the RS-232 Connections section. Debugging tip: The utility software can be used to talk to the monitor over the RS-232 port using the terminal mode. All command and response strings are displayed. This is a good way to establish a connection.
Intermittent lockup on RS-232 interface.	Possible causes: Long cables. Try using a lower baud rate. In some cases, inserting a 50mS delay between commands will help. Noise pickup. Try using shielded cables with the shield connected to a metal backshell at both ends. Don't send reset (RST) commands to the monitor before reading.

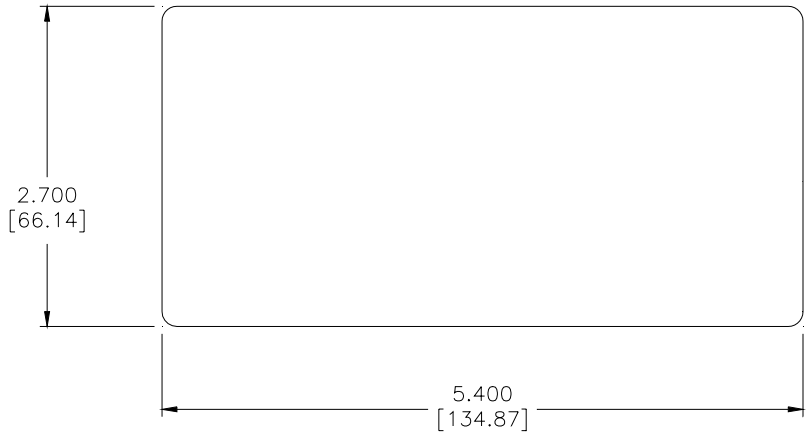
Symptom	**Condition**
Can't talk to the LAN interface.	Possible causes: A Category 5 crossover patch cable is being used where a Category 5 patch cable should be used, or visa-versa. The TCP settings between the monitor and the PC are incompatible. Review the network configuration section. PC Client software not configured to use TCP Data Socket 5000. Debugging tip: The utility software can be used to talk to the monitor over the LAN Data Socket port using the terminal mode. All command and response strings are displayed. Since the software provides the proper interface setup, it is a good way to establish initial connection.

Appendix C: Enclosure Options

Panel Mounting

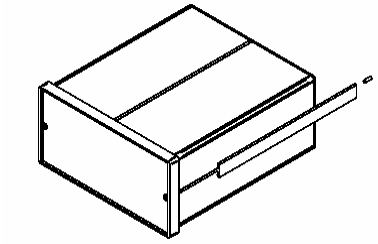
Panel Cutout

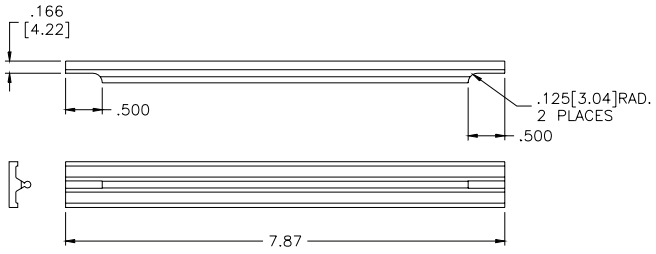
Shown here is a cut-out drawing for panel mounting of the Model 9302/9304.



Panel Mount Kit

The Model 9302/9304 mounts to panel by sliding the enclosure through a panel cut-out hole and then installing the panel mount kit, SII part number 305-240. Drawings and assembly of the panel mount kit are shown here.





Instrument Stand

The Instrument Stand accessory, SII part number 300.011, is used to mount the Model 9302/9304 on a bench top. It tilts the instrument up by 15° for an improved viewing angle.

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